Training on Land Information Management Systems for Sustainable Development in Africa

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ABSTRACT: *Technical and Vocational Education and Training (TVET) institutions can provide an avenue for training on Land Information Management Systems (LIMS) for sustainable development in Africa. A LIMS can be described as a computerised system for land ownership records that usually consists of an accurate, current and reliable map of the land and associated attributes. A well functioning LIMS can provide multiple benefits to a society, some of which include: improving land ownership, enabling land to be used as collateral for credit, developing land markets, improving land taxation, reducing land disputes and enabling rural land reforms among others. These benefits when put together can contribute towards sustainable development, which can be described as the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs. Despite the possible benefits of LIMS, only thirty percent of land in Africa has been formally registered. Due to the low coverage of land registration, a majority of the people in Africa are unable to gain from the possible benefits of land registration. In the areas where registration has been introduced, the records are usually held in paper format, which is susceptible to wear and tear, and can also be misplaced. The lack of proper land records makes it very difficult to unlock wealth which is locked up in land. In order to remedy the situation, there is a need to implement computerised LIMS for effective and efficient use of land. The LIMS can be implemented only if there is a well trained workforce in a country. In this regard, training students in TVET institutions on how to implement LIMS can be one way of creating the required workforce. The main aim of this article is to propose principles of LIMS that should be taught in TVET institutions. In order to determine the key principles, grounded theory was used as the main methodology for this article. The results show that the training should cover technical, legal, organizational and financial aspects of LIMS.*

Keywords: *Land Information Management Systems, Registration, TVET*

I. INTRODUCTION

There is a need to teach principles of Land Information Management Systems (LIMS) in Technical and Vocational Education and Training (TVET) institutions as a means of contributing towards sustainable development in Africa. LIMS can be described as computerised systems on land ownership records that usually consist of accurate, current and reliable maps of land and associated attributes [1]. An effective LIMS can provide multiple benefits to a country, some of which include: improving land ownership, enabling land to be used as collateral for credit, developing land markets, improving land taxation, reducing land disputes and enabling rural land reforms [2]. Despite the potential benefits of LIMS, only about thirty percent of land in Sub-Sahara Africa has been formally registered [3]. In addition, in the areas where land registration has been introduced, the records are usually held in paper form, which is susceptible to wear and tear and can get lost among other disadvantages of paper documents. Thus, a majority of the people are unable to gain from the benefits of LIMS. In order to remedy the lack of LIMS in Africa, there is a need to conduct extensive training on how to implement the systems.

TVET institutions can provide an avenue through which principles of LIMS are taught in African countries. TVET institutions are supposed to impart practical employable skills to learners [4]. The skills should enable individuals and countries as a whole to break out of poverty (Africa Union, 2007). A major advantage of TVET institutions is that the skills can be delivered with varying degrees of complexity to different types of students [4]. As will be shown in this paper, the skills required to develop a LIMS include technical, legal, organisational and financial principles. These skills can be taught to students holistically, in that they cover all the four aspects of LIMS in a single syllabus, or in a disintegrated manner, in which various students focus on some of the aspects of LIMS.

Implementation of a LIMS can contribute towards sustainable development in Africa. Sustainable development can be described as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [2]. A claim has been made that one of the reasons why most African countries are poor is because of informal property rights [5]. In contrast, in the "West" land has formal title deeds, which can be used as collateral for credit from financial institutions [5]. Further, registered

land titles on which digital maps can be created, which contain critical infrastructure such as roads, drainage networks, and electricity networks [6]. In this regard, through a LIMS, people in African countries will be able to gain access to credit which they can use for investments. In addition, the government can use the LIMS as a basis for developing critical infrastructure for the country.

This article describes the main principles of LIMS that should be taught in TVET institutions as a means of enabling economic growth and development in Africa. The next section will describe the methodology that was used to identify the main principles of LIMS, after which each of the principles will be described.

II. METHODOLOGY

This section covers the methodology that was used to identify the key aspects of Land Information Management Systems (LIMS) that can be taught in TVET institutions. The main methodology that was used for this paper is grounded theory. The term grounded theory refers to a qualitative research method, which enables development of theories that offer explanations on a phenomenon under investigation [7]. The theory is said to be "grounded" because it is anchored, or based on existing data [7]. In grounded theory, the data can come from different sources such as interviews, books, documents, videos and newspapers [8].

There are various stages of qualitative analysis in grounded theory. The first stage involves coding, in which the researcher identifies anchors that allow the key points of data to be gathered. The second stage is development of concepts, which are collections of codes of similar content on which the data can be grouped. The third stage is development of categories, which are broad groups of similar concepts that are used to develop the theory. Finally, the theory itself is written down, with details of the phenomenon under investigation [8].

Based on grounded theory, four key categories were selected for developing a theory on the main principles of LIMS. The categories are technical, legal, organisational and financial aspects of LIMS. The main sources of data for this paper were books, conference papers and journal articles related to LIMS. The subsequent sections of this article describe each of the four selected categories, the first being on technical aspects of LIMS.

Despite the descriptions below, no single study can adequately capture all the requirements for establishing a LIMS and this article does not purport to exhaustively capture all aspects of LIMS. However, it seeks to outline key principles, which if fleshed out can provide more details on how to implement an effective and efficient LIMS.

III. TECHNICAL ASPECTS OF LIMS

This section describes some technical aspects of LIMS that should be taught in TVET institutions. The technical aspects are divided into spatial and information technology or computer science components.

A. *Spatial Aspects of LIMS*

In order to be able to implement LIMS, students in TVET institutions should be taught spatial principles. The spatial principles will provide a means of capturing land parcel boundaries and entry of the same data in databases. The spatial principles are usually taught under the discipline of Land Surveying, which is also referred to as Geomatics or Geospatial Engineering [9]. The training on LIMS can borrow from the key principles of surveying, to teach principles that can be used to establish and capture land boundaries. The training should cover spatial subjects such as Geodesy and Plane Surveying techniques. In this regard, Geodesy can be described as the science of determining the shape of the earth, its orientation and gravity field [10]. Based on Geodesy, the graduates from TVET institutions will be able to establish survey control points, from which parcel boundaries can be measured. The Plane Surveying procedures that the students should learn include: the ability to make measurements using tapes and cadastral bands, ability to run a traverse using Total Station Equipment and the ability to make measurements using Global Navigation Satellite Systems (GNSS).

The students should also have an ability of developing hard copy and digital maps of the land parcels. The students should learn how to draw maps of land parcels, using Computer Aided Design (CAD) software such as AutoCAD or Carlson. The students should be able to manipulate the CAD drawings in Geographic Information Systems (GIS) software, in which the maps can be connected to the necessary attribute data. In this case, a GIS can be defined as a system for capturing, storing and analysing spatially related data [11].

Another spatial skill that the training should cover is photogrammetry, which can be used to quickly capture land parcel boundaries. In some cases, ground land survey methods can be slow and expensive. In this regard, aerial photogrammetry has been described as one of the components of a faster system of land registration that is referred to as "fit-for-purpose" land administration [12]. The quick methods of registration

have also been referred to as "pro-poor" land registration systems, which can contribute to economic growth and development in Africa [13]. In a country like Kenya, aerial photogrammtery was used for fast land adjudication in some parts of the country, by the colonial and post-independence governments. Today, the aerial mapping can also be done using Unmanned Aerial Vehicles (UAVs).

This section has described spatial aspects that should be taught to students in TVET institutions. Apart from enabling the establishment of LIMS, the spatial skills will also enable the students to gain employment in other fields such as engineering, construction and environmental monitoring. The students should also learn principles of information technology or computer science that will be used to develop the systems. The next section describes some of the computer principles.

B. Information Technology/ Computer Aspects of LIMS

In order to be able to implement LIMS, the students should also learn principles of information technology or computer science. As stated earlier, a major challenge in Africa is that the few existing land records are held in paper format, which has multiple disadvantages [14]. Computerisation of land records will enable connection to financial institutions and tax authorities for financial services and to local authorities for better service delivery [2]. The training on information technology aspects will also not only enable students to implement LIMS but also enable them to gain employment in other computer related fields.

A key principle of computers that should be imparted to students is design, implementation, and management of database systems. In essence, a LIMS is a database which contains land related data. In this regard a "database is a shared, integrated computer structure that stores a collection of end user raw facts of interest to the end user and metadata, which is a description of the data" [15]. The training should include Structured Query Language (SQL), which is a programming language for managing data within relational database management systems. The course should also cover database management systems such as Oracle or Microsoft SQL Server Express. The students should also know how to build multi-user geodatabases, which can handle spatial data and can be accessed by multiple users simultaneously [16]. The database systems, especially the multi-user capabilities, will enable LIMS to be connected with various agencies, such as government agencies, local governments, banks and revenue collection authorities.

The course should also cover connection of databases to the internet. The connection between the internet or intranet and databases can enable quick retrieval of land information. In order to establish the connections, the students need to learn web design software such as the HyperText Markup Language (HTML), Extensible Markup Language (XML) and Java Script among others. The students should also learn server-side scripting languages such as PHP or Active Server Pages (ASP). By learning the appropriate programming languages, graduates from TVET institutions will not only be able to develop appropriate LIMS for their countries, but also gain employment in other information technology related sectors. In Europe similar programming languages have been used to develop a Geoportal known as INSPIRE [17].

Apart from the technical aspects of LIMS, TVET institutions should also teach legal aspects of LIMS. The next section describes legal principles that should be covered.

IV. LEGAL ASPECTS OF LIMS

The legal aspects should cover people's understanding of land ownership or rights to land. In most African countries, where registration has been introduced, it has been done based on "Western" legal concepts which usually include ownership [18]. In "Western" principles, ownership includes the ability to exclude others from the land, ability to sell land and ability to obtain rent from land [18]. In contrast, in African custom, rights to land were usually shared. In this regard, different people could simultaneously gain access to the same piece of land, either at the same time or in different seasons [19]. As an example, on one piece of land, some people could have rights to build houses, others rights to grow crops, others rights to graze livestock on the land after harvesting [19].

Based on the differences on how Africans and "Western" societies view ownership, there is a need to teach students the different legal concepts, so that they can assist in developing more appropriate means of registration for Africa. In an attempt to develop a system of land registration that recognizes the various social dimensions of land in Africa, a Social Tenure Domain Model (STDM) has been developed [20]. The STDM basically is a means of capturing the various continuum of rights that can exist over land [20]. A Land Administration Domain Model (LADM) has also been developed as a means of showing Rights, Restrictions and Responsibilities (RRRs) that should be captured in a LIMS [21]. Despite the development of the STDM and the LADM, there is still a need to either customise the models to fit country specific contexts.

The training on legal aspects should also capture dynamic aspects of land. In general, land issues can be viewed either from a static perspective or from a dynamic view [22]. The static aspect of registration is concerned with the linkages between a person and the land to which they hold rights i.e. whether it is the "Western" or customary view of holding land. In the dynamic view, the focus is processes used to register or transact in land [22]. Thus, legal principles of LIMS should capture how the dynamic aspects are handled in each country. Apart from the legal aspects, the training should also cover organisational principles as described in the next section.

V. ORGANIZATIONAL ASPECTS OF LIMS

In order to enable successful implementation, the training should also cover organisational aspects of LIMS. There should be clarity on organizational linkages from the meta to the micro levels. At the meta level, it should be clear how international and national agencies can collaborate to enable implementation of LIMS. At the micro level, there should be clear organizational structures, which outline how different roles in the implementation of LIMS should be undertaken. As an example, at the higher or meta level, it should be known how country governments can seek assistance from international donor agencies such as the World Bank. At the micro level, it should be known how various individuals in the organization, who have different expertise work together to implement the LIMS. In this regard, the institutional challenge is how to establish appropriate organisational structures to manage integration of spatial data in information systems for sustainable development [23].

The organizational structures for LIMS should be guided by clear policies and laws. In the development of laws for LIMS, there are various factors that should be included, such as, "establishing an independent public land registration institution with clear powers; establishing simple administrative systems for land transfer and property formation; establishing quick and simple procedures for mortgage and forced sales; specifying the administrative role of the agencies and actors involved" [23]. The requirements for creating the policies show that in order for the implementation of LIMS to work, there is a need for clarity on how and by whom tasks are to be undertaken.

This section has described some organizational aspects that should be imparted to students. It is in no way comprehensive, but seeks to act as a guide on some issues that should be captured if LIMS are to be successfully implemented in African countries. The next section describes financial aspects.

VI. FINANCIAL ASPECTS OF LIMS

The students should learn how implementation of LIMS will be financed and how funds generated from the systems will be used. The training should include formal and informal funding options for LIMS. Currently, there is a guideline on "Costing and Financing of Land Administration Services (CoFLAS)" [24]. The CoFLAS tool is geared towards formal land rights within the continuum of land rights. Thus, in the training, there is need for the students to conduct research on how funding can be undertaken for informal rights to land, which are more prevalent in Africa. The students also need to understand how Public Private Partnerships (PPPs) work, as a means of funding LIMS. In addition, some aspects of how donor funding works should also be imparted to the students, so that they can in future assist in acquiring funds for the LIMS.

There should also be an outline on how funds generated from the LIMS will be used. In essence, once the LIMS is up and running, it is expected to bring in revenue for the government. There will be fees charged for various services such as land subdivisions; land transfers mortgage facilities and sale of maps among others [2]. The revenue can be either assigned to part of the running costs of the system or diverted to other government projects [24]. Hence, there should be a policy guideline on how the revenue will be used.

VII.   CONCLUSION

This paper has provided key technical, legal, organisational and financial principles of LIMS that should be taught to students in TVET institutions as a means of contributing towards sustainable development. In Africa, only thirty percent of land has been formally registered. Thus, implementation of LIMS will help to increase the percentage and enable people to gain from the benefits of registration. Training students in TVET institutions will provide the necessary manpower to implement the systems. The training should be holistic and should cover all aspects of LIMS as described above. This paper has provided a synopsis on the key principles of LIMS that should be covered in the training. Nonetheless, there is still more work to be done on how the training can be delivered and the exact nature of curriculum that would fit TVET institutions.

References

[1]   Dale, P. F., & McLaughlin, J. D. (1988). Land information management: an introduction with special reference to cadastral problems in Third World countries. Retrieved from http://agris.fao.org/agris-search/search.do?recordID=XF2015016826

[2]   Williamson, I. P., Enemark, S., Wallace, J., & Rajabifard, A. (2010). Land administration for sustainable development. ESRI Press Academic Redlands, CA.

[3]   Zevenbergen, J., Augustinus, C., Antonio, D., & Bennett, R. (2013). Pro-poor land administration: principles for recording the land rights of the underrepresented. Land Use Policy, 31, 595–604

[4]   Africa Union. (2007). Strategy to revitalize technical and vocational education and training (TVET) in Africa. In Meeting of the Bureau of the Conference of Ministers of Education of the African Union (COMEDAF II+) (pp. 29–31). Retrieved from http://efanet.gm/pub/TVET.pdf

[5]   De Soto, H. (2000). The mystery of capital: Why capitalism triumphs in the West and fails everywhere else. Basic books.

[6]   Rahman, A. A., Hua, T. C., & Van Oosterom, P. J. M. (2011). Embedding 3D into multipurpose cadastre. In Proceedings of the FIG Working Week 2011" Bridging the Gap between Cultures" & 6th National Congress of ONIGT, Marrakech, Morocco, 18-22 May 2011. International Federation of Surveyors (FIG); Ordre National des Ingénieurs Géomètres Topographes (ONIGT). Retrieved from http://repository.tudelft.nl/view/ir/uuid:472b7607-86f3-4103-921a-92e2f483ae30/

[7]   Corbin, J. M., & Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. Qualitative Sociology, 13(1), 3–21.

[8]   Charmaz, K., & Smith, J. A. (2003). Grounded theory. Qualitative Psychology: A Practical Guide to Research Methods, 81–110.

[9]   Konecny, G. (2002). Recent global changes in geomatics education. International Archives of Photogrammetry Remote Sensing and Spatial Information Sciences, 34(6), 9–14.

[10]   Torge, W., & Müller, J. (2012). Geodesy. Walter de Gruyter. Retrieved from https://books.google.com/books?hl=en&lr=&id=RcfmBQAAQBAJ&oi=fnd&pg=PR5&dq=Geodesy&ots=KRxfo12WNu&sig=YZDncjyl0wxRdX4muLNgXTx1RrM

[11]   Longley, P. (2005). Geographic information systems and science. John Wiley & Sons. Retrieved from https://books.google.com/books?hl=en&lr=&id=toobg6OwFPEC&oi=fnd&pg=PR9&dq=geograpgic+Information+Systems&ots=yjZarKEppl&sig=swP92cARMwtDuqkfLoePYos1CLQ

[12]   Enemark, S. (2013). Fit-for purpose Land Administration. GIM International, 27(7), 26–29.

[13]   Zevenbergen, J., Augustinus, C., Antonio, D., & Bennett, R. (2013). Pro-poor land administration: principles for recording the land rights of the underrepresented. Land Use Policy, 31, 595–604.

[14]   Kuria, D., Ngigi, M., Gikwa, C., Mundia, C., & Macharia, M. (2016). A Web-Based Pilot Implementation of the Africanized Land Administration Domain Model for Kenya—A Case Study of Nyeri County. Journal of Geographic Information System, 8(2), 171.

[15]   Rob, P., Coronel, C., & Crockett, K. (2008). Database systems: design, implementation & management. Cengage Learning EMEA. Retrieved from https://books.google.com/books?hl=en&lr=&id=SXFAoyVusyMC&oi=fnd&pg=PR13&dq=Database+Systems+Design+Implementation+Management+Peter+Rob+Carlos+Coronle&ots=YJuFUpO4Ie&sig=UFuPOiSo-TmpNqmIF9pivWnozEQ

[16]   Zeiler, M. (1999). Modeling our world: the ESRI guide to geodatabase design. ESRI, Inc. Retrieved from https://books.google.com/books?hl=en&lr=&id=qAeScoyTqIC&oi=fnd&pg=PP9&dq=Building+Geodatabase&ots=M9n983FER2&sig=Ymk1Lg1nSYshuhBEM1B3U2BrUSM

[17]   Bernard, L., Kanellopoulos, I., Annoni, A., & Smits, P. (2005). The European geoportal—-one step towards the establishment of a European Spatial Data Infrastructure. Computers, Environment and Urban Systems, 29(1), 15–31.

[18]   Bromley, D. W. (2009). Formalising property relations in the developing world: The wrong prescription for the wrong malady. Land Use Policy, 26(1), 20–27.

[19]   Cotula, L., & Chauveau, J.-P. (2007). Changes in customary land tenure systems in Africa. Iied. Retrieved fromhttps://books.google.com/books?hl=en&lr=&id=u8ka6Mu6SoC&oi=fnd&pg=PA1&dq=Changes+in+Customary+Land+Tenure&ots=AUXiQ2DLep&sig=532iqTBUJayKDdL0hCXRHr0JQBM

[20]   Augustinus, C., Lemmen, C. H. J., & Van Oosterom, P. J. M. (2006). Social tenure domain model requirements from the perspective of pro-poor land management. In Proceeding of the 5th FIG regional conference (pp. 8–11). Retrieved from https://www.fig.net/resources/proceedings/fig_proceedings/accra/papers/ps03/ps03_02_lemmen.pdf

[21] Lemmen, C. H. J., Van Oosterom, P. J. M., Thompson, R. J., Hespanha, J. P., & Uitermark, H. T. (2010). The modelling of spatial units (parcels) in the Land Administration Domain Model (LADM). In Proceedings of the XXIV FIG International Congress 2010: Facing the Challenges-Building the Capacity, April 2010. International Federation of Surveyors, FIG. Retrieved from http://repository.tudelft.nl/view/ir/uuid:3306bb0d-9002-481a-9e7d-6c1f4ff81224/

[22] Zevenbergen, J. (2002). Systems of land registration aspects and effects. TU Delft, Delft University of Technology. Retrieved from http://repository.tudelft.nl/assets/uuid:44e404e9-c1e9-4c20-b1e1-977ee9c11570/ceg_zevenbergen_20021111.pdf

[23] Enemark, S. (2004). Building land information policies. In Proceedings of Special Forum on Building Land Information Policies in the Americas. Aguascalientes, Mexico (pp. 26–27). Citeseer. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.532.6695&rep=rep1&type=pdf

[24] Burns, A., Fairlie, K., & Haile, S. (2015). Costing and financing of land administration services. Retrieved from http://mycoordinates.org/costing-and-financing-of-land-administration-services/