Land Administration Information and Transaction Systems: State of Practice and Decision Tools for Future Investment

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Disclaimer

This document was prepared by Land Equity International for the Millennium Challenge Corporation. The findings, interpretations and conclusions expressed in this material are those of the material's author, and are not necessarily those of the Millennium Challenge Corporation.

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Acronyms

3D	Three dimensional
API	Application Programming Interface
ArcGIS	GIS software platform supplied by ESRI
BaaS	Backend as a Service
BPMN	Business Process Model and Notation
BPR	Business Process Reengineering
CAT6	Category 6 cable which is a standardized twisted pair cable for Ethernet and other network physical layers
CoFLAS	Costing and Financing of Land Administration Systems (GLTN)
CORS	Continuously Operating (GNSS) Reference Station
COTS	Commercial Off the Shelf
DBMS	Database management system
DFID	Department for International Development (UK, now part of FCDO)
ECA	Europe and Central Asia
ESRI	Environmental Systems Research Institute, an international supplier of GIS software
EU	European Union
FaaS	Function as a Service
FAO	Food and Agriculture Organization of the United Nations
FCDO	Foreign, Commonwealth& Development Office (UK)
FIG	International Federation of Surveyors
FLOSS	Free/Libre Open Source Software
FOSS	Free and Open Source Software
GeoODK	Geographical Open Developer Kit
GIS	Geographic Information System
GDPR	General Data Protection Regulation (European Union)
GLTN	Global Land Tool Network
GML	Geography Markup Language
GNSS	Global Navigation Satellite Systems
GNU	Operating system and extensive collection of computer software composed wholly of free software
HR	Human resources
HTTP	Hypertext transfer protocol
HTTPS	Extension of HTTP
ICT	Information and Communication Technologies
ID	Identity Document
IDE	International Development Environment
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IRR	Internal rate of return
IS	Information Systems
ISLA	Information system for land administration (developed under SIDA project in Ethiopia).
ISO	International Organization for Standardization
ISP	Internet service provider
IT	Information Technology
JSON	JavaScript Object Notation
JTC	Joint Technical Committee

JTK	Java Toolkit
LA	Land Administration
LAaaS	Land Administration as a Service
LAS	Land Administration System/s
LADM	Land Administration Domain Model
LAMP	Land Administration Modernization Program (ESRI)
LAN	Local Area Network
Land IT System	Land Administration Information and Transaction System
LandXML	Non-proprietary file format that stores civil/survey data such as points, faces, etc.
LEO	Low Earth Orbit
LIC/LMIC	Low income/lower-middle income countries
LIFT	Land Investment for Transformation (DFID program in Ethiopia)
LGAF	Land Governance Assessment Framework (World Bank)
LRaaS	Land Registration as a Service
LTR	Land Tenure Regularization (DFID program in Rwanda)
MAST	Mobile Application for Secure Tenure (tool developed by USAID)
MCC	Millennium Challenge Corporation
NSDI	National Spatial Data Infrastructure
O&M	Operations and maintenance
OCR	Optical Character Recognition
OGC	Open Geospatial Consortium
OMO	Organization and Management Operations
PC	Personal computer
PDF	Portable Document Format
PDF/A	ISO standardized version of PDF for archival purposes
PPP	Public Private Partnerships
RFC	Request for Comments
ROI	Return on investment
QGIS	FOSS cross-platform desktop GIS application
SaaS	Software as a Service
SDG	Sustainable Development Goal
SDI	Spatial Data Infrastructure
SDK	Software Development Kit
SIDA	Swedish International Development Cooperation Agency
SIM	Subscriber Identity Module (a microchip in a mobile phone that connects it to a particular phone network)
SOA	Service Oriented Architecture
SOLA	Solutions for Open Land Administration
SOW	Scope of Work
SQL	Structured Query Language
STDM	Social Tenure Domain Model
TCO	Total Cost of Ownership
TI	Transparency International (https://www.transparency.org/en/)
TNA	Training Needs Assessment
TOR	Terms of Reference
TV	Television
UAV	Unmanned Aerial Vehicle

UK	United Kingdom
UML	Unified Modelling Language
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UN-GGIM	United Nations Committee of Experts on Global Geospatial Information Management
UPS	Uninterrupted Power Supply
URISA	Urban and Regional Information Systems Association
US	United States of America
USAID	United States Agency for International Development
VNC	Virtual Network Computing
VPN	Virtual private network
WAN	Wide Area Network
XML	Extensible Markup Language

Glossary

This glossary sets out definitions for some of the key terms used in this document.

Cadastre: is normally a parcel-based, and up-to-date land information system containing a record of interests in land (e.g. rights, restrictions, and responsibilities). 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. It may be established for fiscal purposes (e.g. valuation and equitable taxation), legal purposes (conveyancing), to assist in the management of land and land use (e.g. for planning and other administrative purposes) and enables sustainable development and environmental protection.[1]

Commercial off the Shelf (COTS) Software: Are packaged solutions which are then adapted to satisfy the needs of the purchasing organization (rather than the commissioning of custom-made, or bespoke, solutions. (reference: https://en.wikipedia.org/wiki/Commercial_off-the-shelf)

Configuration: Is where the behavior of an open source or commercial software package is modified (typically by a system administrator) by changing system settings so that the package better reflects the requirements of a particular implementation of the software. These system settings are usually made through the software package's admin console and they do not require a new "build" (compilation) of the software, so the version of the software does not change.

Customization: Is where the code of an open source or commercial software package is modified by a software developer to change the original behavior of the package to better reflect the requirements of a particular implementation and requiring a new "build" (compilation) using the software package's Software Development Kit (SDK) and resulting in a new distinct version of the software package.

Data Model: is an abstract model that organizes elements of data and standardizes how they relate to one another and to the properties of real-world entities. The main aim of data models is to support the development of information systems by providing the definition and format of data. If the same data structures are used to store and access data, then different applications can share data. (reference: https://en.wikipedia.org/wiki/Data_model)

Financing: Refers to the approach in ensuring that funding is provided to support the provision of services. Land administration may be financed in several ways including:

a) as direct budget allocation by government at varying levels (national, state/province, local government, district etc.); or

b) by the retention of some or all the fees and charges collected; or

c) by private parties, including private sector service providers or those providing a service based on land administration records; or

d) as loans provided by government or financial institutions; or

e) in the case of developing countries by loans or grants provided by development partners; or

f) by a mixture of the above.

[1] Definition from the FIG Bathurst Declaration, Appendix 4:
https://www.fig.net/resources/publications/figpub/pub21/figpub21.asp#APPENDIX%20IV

In some countries land administration is financed under a model of **self-financing**: whereby the cost of the provision of land administration services is covered by the retention of some or all of the fees and charges collected by the land administration agency.

Free/Libre Open Source Software (FLOSS): Is software that can be classified as both free software and open source software. That is, anyone is freely licensed to use, copy, study, and change the software in any way, and the source code is openly shared so that people are encouraged to voluntarily improve the design of the software. (reference: The GNU Project -- GNU.org. 2018-06-12)

Land administration: Is the set of systems and processes for making land tenure rules operational. It includes the administration of land rights, land use regulations, and land valuation and taxation. Land administration may be carried out by agencies of the formal state, or informally through customary leaders. Usage in this paper does not include IT tools that are used only for land-related information gathering.

Land administration information and transaction system: Referred to in this document as Land IT System (for brevity), the supporting infrastructure and operational procedures – typically digital – that support the delivery of land administration services including the management of data for land administration, including acquiring, processing, storing, updating and distributing information about land and land administration transactions.

Open Source: refer to *Free/Libre Open Source Software* above

Registry: The term 'registry' or 'register' is used to denote the organization where the information on registered land rights is held. Information on registered land is typically textual and spatial, with the former typically maintained in a registry and the later in a cadastre office. In some countries there is a combined organization that has both sets of data and in some countries this office is called the cadastral office (in the Balkans, for example). In others there are separate registry and cadastre offices. For this paper, it is clearly specified between the use of the terms where registry and cadastre activities occur separately.

Revenue: Is the land related fees, charges and taxes that are collected by the government associated with the provision of land administration services. This revenue is typically collected on an annual basis or based on transactions or the provision of services or data/information.

Self-financing: Refer to *Financing* above

Software Architecture: Refers to the fundamental structures of a software system and the discipline of creating such structures and systems. Each structure comprises software elements, relations among them, and properties of both elements and relations. It functions as a blueprint for the system and the developing project, laying out the tasks necessary to be executed by the design teams. (reference: https://en.wikipedia.org/wiki/Software_architecture)

Spatial data infrastructure (SDI). Describes the fundamental spatial data sets, the standards that enable them to be integrated, the distribution network that provides access to them, the policies and administrative principles that ensure compatibility among jurisdictions and agencies, and the people, including users, providers, and other stakeholders. Often used in the context of a country's national spatial data infrastructure, or NSDI.

Total Cost of Ownership: Refers to an approach to rigorously identify all costs associated with the development and operation of a new information technology system over the lifecycle of the system

These definitions have been drawn from the following references:

FAO Land glossary: http://www.fao.org/docrep/005/y4307e/y4307e09.htm

GLTN Land glossary: http://web-archive-net.com/page/3224432/2013-11-24/http://www.gltn.net/index.php/about-us/land-glossary?view=glossary&letter=a

FIG Bathurst Declaration, Appendix 4: https://www.fig.net/resources/publications/figpub/pub21/figpub21.asp#APPENDIX%20IV

Williamson, Enemark, Wallace, Rajabifard (2009): Land Administration for Sustainable Development, glossary, pages 448 to 457

http://www.esri.com/landing-pages/industries/land-administration/e-book#sthash.Lp4BYcKW.aZSH5oh6.dpbs

Executive summary

The Millennium Challenge Corporation (MCC) has significantly invested in both nationwide and local level land administration information and transaction systems (Land IT Systems) in many of its partner countries. MCC has identified key lessons but is seeking to promote a comprehensive and systematic approach to both strengthening project sustainability and assessing and mitigating investment risk. This paper has been prepared for MCC by Land Equity International to address that need.

This paper sets out the current state of play of investing in information and communication technology for Land IT Systems. It identifies lead thinking around how and when to address the opportunities and challenges of designing, implementing, and sustaining the performance of Land IT Systems. The paper foreshadows a suite of analytical tools that will be designed to guide and facilitate MCC's assessment of the appropriateness and scope of potential investments in Land IT Systems.

Some clear lessons can be drawn from recent experience in developing Land IT Systems. The World Bank has noticed some issues with sustainability and the ease of completing major upgrades to existing land IT Systems technology. As a result, on recent World Bank projects, in-house information, communications technology (ICT) system development and incremental approaches have often proved easier to implement and this approach generally provided workable systems that become operational quickly and built in-house capacity. A clear ICT or sector strategy provides a strong basis for decisions on investment. Undertaking business process reengineering and improving data quality should start early or in parallel with ICT development and projects must be designed to ensure sustainability. Funds should be available to provide technical assistance for project and contract management, quality assurance and capacity building. There are some trends emerging. The World Bank has become more cautious about supporting country clients' investments in large Land IT Systems in the absence of other related policy and conditions which are more conducive to institutional and financial sustainability and FCDO (formerly DFID) recognizes the need to consider the wider strategic and institutional context before investing in large first registration projects.

The challenges in implementing and maintaining Land IT Systems in lower income countries/lower-middle income countries (LIC/LMIC) fall across policy, legislative, institutional, social, and enabling technology environments. There is a gap between policy formulation often based on international models and the translation of policy into actions and implementation. Many of the challenges are well-known: political will and capacity dimensions; software and system implementation complexity; public distrust; inadequate system maintenance; and insufficient interoperability. Amongst the challenges, there are clear opportunities drawing from neighboring fields, including improving data privacy regulations, adopting system security measures, and embracing private sector capacity. In addition, there is a clear need to identify 'leapfrog' technological solutions applicable to LIC/LMICs to enable these countries to avoid 'frontrunner' mistakes by adopting best practices.

A closer look at technology trends in Land IT Systems – both in terms of what is being implemented, as well as what innovations are emerging – provides the basis for context-appropriate project design choices. The context of the existing operating environment is a key project consideration that underpins technology choice and adoption. Context includes the reliability of critical infrastructure, such as power supply reliability and network connectivity, as well as the availability of expertise, existing capacity, and the need for training.

In addition to understanding existing operating environment contexts, significant preparatory work is required to promote sustainable systems. Preparatory work should include: a clear definition of functional and non-functional requirements; the description of implementation options to meet these specific requirements; appropriate software architecture description; risk analysis; and a total cost of ownership analysis (for at least the first 10 years of operation). Forward-looking system designs will need to carry out a holistic review of the legal framework, public sector policy framework, broad

technology initiatives and e-governance policies, business process re-engineering and reform options and organizational infrastructure.

The institutional arrangements for the provision of land administration services typically include roles and responsibilities for local government, private sector service providers and possibly other institutions. Any investment in Land IT Systems needs to consider these other roles in the delivery of land administration services, both the current arrangements and any likely future arrangements. Governments generate land-related revenue from land/property taxes and user fees and charges for the provision of land administration services. Many governments have adopted practices to allow land agencies to retain some or all the revenue from user fees and charges to fund some or all the expenditure required to provide land administration services. The policy of allowing land agencies to retain some or all revenue is but one approach in using the revenue from user fees and charges to fund the provision of land administration services. Governments have the option of using the revenue from the provision of services to offset or to fully fund the cost of accessing recently developed Land Administration as a Service (LAaaS) offerings. Sharing the revenue from user fees and charges can be the key basis for the payments to a private party for the provision of services under a public-private partnership (PPP) arrangement.

The following key risks in investing in Land IT Systems are identified:

- **Policy and Legal Framework**
    - Political economy risks that cannot be managed
    - Insufficient political will for reform
    - Policy and legal framework for land sector reform is not in place
- **Institutional Reform**
    - Insufficient buy-in, capacity at the institutional level
    - Weak land records management system(s)
    - Inefficient land administration business processes
    - Limited geographic coverage of the land administration system
- **Technology**
    - Weak or unclear proposal put forward for investment in a Land IT System
    - Failure to integrate the Land IT System into daily workflows
    - Appropriate staff are not available to take on critical tasks
    - Failure to provide appropriate office facilities
    - Inadequate infrastructure (power, communication lines, Internet connectivity)
- **Financial Analysis**
    - Insufficient willingness for the public to pay for or demand services
    - Failure to align revenue with costs
    - Inability/unwillingness of government to fund operations and maintenance
- **Sustainability**
    - Loss of trained staff and qualified technicians
    - Lack of investment by government in the provision of land administration services.

Strategies to mitigate these risks in the initial discussions with government and in the design of projects to develop Land IT Systems are proposed and a preliminary structure has been prepared for the Assessment and Design toolkit. The information in this paper will provide the basis for the development of a comprehensive Assessment and Design toolkit.

1 Background

This paper has been prepared for the Millennium Challenge Corporation (MCC) by Land Equity International. The paper sets out strategic thinking on investing in information and communication technology for land administration information and transaction systems (henceforth referred to as "Land IT Systems"). The paper also identifies how and when to address the opportunities and challenges of designing, implementing, and sustaining the performance of Land IT Systems. The paper foreshadows a suite of analytical tools that will be designed to guide and facilitate the assessment of, and scoping for potential Land IT System investments. The following background sections provide brief information addressing the importance of this work, what it aims to achieve and the target audience.

1.1 Why is this study important?

MCC has invested in both nationwide and local level Land IT Systems in many of its partner countries. MCC is seeking a comprehensive analytical framework to help ensure that the operability, sustainability, political, institutional, and risk dimensions are systematically and comprehensively considered.

The eventual framework – a suite of analytical tools – will have the primary objective of supporting MCC in designing and scoping land investments in MCC partner countries. The requirement for Land IT Systems in a country may also be for a system upgrade rather than a completely new system built from scratch and the analytical framework will therefore need to support assessments in a broad range of contexts and situations. This paper is preparatory and a design input for the development of the assessment and design toolkit.

1.2 Who is this study for?

This paper provides foundational information to identify and design in a next phase a suite of analytical tools to guide and facilitate MCC's assessment of, and scoping for potential Land IT Systems investments.

The core audience of this document is MCC land experts. Others may also draw value from this document – including other development partner or government decision-makers and project implementers.

The focus of the paper is on the lower income and lower-middle income countries (LIC/LMIC) where MCC works, so whilst a discussion of technologies applies to all contexts, recommendations that have been made are primarily for environments where the land sector faces particular technological and institutional challenges, with specific emphasis on low-income countries.[2]

1.3 Purpose of this study

The primary focus of this work is to identify the factors to consider in assessing investments in the development and implementation of Land IT Systems that provide a comprehensive system to register and record property rights and support for the processing of subsequent associated transactions.[3] This document considers the requirement to digitize existing records but does not focus on the technology choices for tools more narrowly used to collect and integrate rights and boundary information as part of a systematic rights formalization or rights regularization.

[2] The MCC website, mcc.gov, identifies "candidate countries" on an annual basis. The methodology for this is available at https://www.mcc.gov/resources?fwp_resource_type=selection-criteria-and-methodology-report .

[3] Subsequently referred to as "land administration transactions" and including cadastral processes to approve and record changes to the (spatial) cadastre component of Land IT Systems.

1.4 Structure of this document

This paper is structured in 8 sections and covers the following topics:

- **Section 1** – is this background and introduction to the paper, setting out the objective of the paper, the intended audience and the scope of land administration and transaction systems.
- **Section 2** – draws on recent reviews of land administration reform initiatives to provide an overview of the recent, relevant lessons and experience.
- **Section 3** – sets out the challenges faced in designing and implementing land sector reforms involving IT systems in LIC/LMIC.
- **Section 4** – covers the technology trends impacting on land administration information and transaction systems.
- **Section 5** – discusses two key strategic questions: (a) what service delivery modes do governments use to provide land administration services; and (b) how is the ongoing provision of land administration services going to be financed?
- **Section 6** – discusses current land administration reform practices and design checklists, the process of planning for sustainability and assessing and mitigating risk, and the process of making the decision to invest in improving the provision of land administration services and Land IT Systems.
- **Section 7** – sets out a preliminary structure for the assessment and design toolkit and the conclusions.

2 Learning from recent reform experience

The preparation of this paper has benefited from the ability to draw upon recent detailed reviews of land sector reform initiatives. Reports by English et al (2019) and Törhönen (2017), review recent land sector project experience of the Department for International Development (DFID, now FCDO) and the World Bank, respectively. The authors of this paper were requested by MCC not to undertake a detailed, in-depth review of recent project experience. However, to provide context for the paper, the authors felt that it was important to set out an overview of the lessons from recent, relevant experience. The overview covers the following topics:

- The difficulty of strengthening land administration information and transaction systems generally.
- Experience, guidelines, and lessons from development partner experience.
- Experience of new players in improving land administration systems.

2.1 Why is system reform so difficult?

In all countries land is a fundamental resource that needs to be managed and administered in a manner that addresses typically broad political, economic, social, and environmental objectives for the current population and for the benefit of future generations. An important tool in ensuring that land addresses these broad objectives is a land administration system, a system that typically includes "the administration of land rights, land use regulations, and land valuation and taxation."[4] Typically a land administration system is comprised of textual records that define rights, responsibilities and restrictions and spatial records that define the extent over which these rights, responsibilities and restrictions apply.

Land administration agencies play an essential role in recording, protecting, and making publicly available information on property rights and they provide the systems to record transactions with these rights over time. Establishing and maintaining an effective land administration system is not without difficulties. The procedures applied in the land administration agency are typically defined by policy and legislation that have evolved over a long period of time. The procedures are usually described in detailed work process manuals and applied by civil servants, often with the support of private-sector service suppliers such as notaries and private cadastral surveyors. The procedures and the vested interests of staff and private-sector service providers can also entrench the existing bureaucracy and create barriers to change. Property is a valuable asset in any society, and land administration agencies are vulnerable to rent seeking.

Land administration systems have a long-tradition of paper-records, although now ICT is readily and successfully applied. However, in LIC/LMIC paper records may not be well-maintained, and the records are unlikely to be in digital form, leading to the loss of information, physical destruction of records, fraud and alteration of records, and other issues. Other common difficulties, for land administration agencies in LIC/LMIC include: highly centralized, under-resourced offices that are difficult to access; complex procedures that can be expensive and time consuming[5] for those seeking to register property and difficult for government to implement and maintain; limited resources and training; difficulties and limited incentives for staff in land administration agencies and other key government agencies to

[4] Definition of "land administration" in the FAO Land Glossary http://www.fao.org/3/y4307e/y4307e09.htm.

[5] The processes are not only expensive and time consuming in the abstract, but also as a percentage of the property value and expensive and time consuming compared to cost-as-percent-of-value for the same land administration service in the more developed economies.

share information and data; high, unrealistic fee structures; limited incentives for change among staff; lack of a critical mass of property registered or recorded in the system; and a lack of public perception and/or awareness of the benefits and requirements to register property and property transactions. Various strategies have been developed to address these issues. For example, in Georgia and many other countries, the business process was re-engineered to streamline procedures and to separate the front office (where the interaction with the public occurs) and the back office (where land records are maintained, updated and services actioned).

In many LIC/LMIC, formal land administration systems do not function well, do not represent reality on the ground, or quickly become outdated when changes take place in access and rights, even where a development partner funds a significant program aimed at addressing some of these issues. These programs have mixed success, in part because the projects have not been sufficiently effective in realizing an efficient, sustainable land administration system that responds to demand for services. English et al (2019) in reviewing the significant DFID-funded land tenure regularization programs in Rwanda and Ethiopia, noted the importance that successful land tenure regularization requires functional, service-oriented land institutions to provide ongoing land administration services and the development of accurate, comprehensive digital land information systems to deliver sustainable outcomes in the longer term.

2.2 Development partner experience

Investment in ICT has been a key strategy in improving the efficiency of land administration, particularly in the large land-sector projects funded by the World Bank. However, as Törhönen (2017:26) notes, the investment in ICT in World Bank-funded projects is not a cure-all. Automating poor or overly complex procedures does not improve efficiency. This caution is reflected in a recent cross-cutting analysis of land registry management (Princeton University, 2018), noting that investing large amounts of money in digital systems may be counterproductive as it may divert attention from the more fundamental tasks of building capacity, digitizing/converting existing data, registering unregistered property and improving business processes.

FAO (2017) list the following strategic options for developing ICT systems to support land administration:

- Using in-house skills,
- Using local contractors,
- Using state-owned enterprises,
- Using international contractors.

It is also possible to adopt a strategy that is a combination of the approaches listed above. There are also variations on these approaches. Many Land IT Systems have been developed by staff and technical advisers deployed under a land administration reform project, which is a variation of the approach of using in-house resources. An example of this was the ISLA software that was developed for Amhara region in Ethiopia in the early 2000s under a Swedish International Development Cooperation Agency (SIDA)-funded land administration reform project (Orgut, 2010). This system adopted a low-cost development approach with the direct involvement of local staff and experts. The system however failed to serve the long-term needs of the region as it had limited functionality, particularly with regards to spatial data, and relied on the ongoing support of the international adviser who had developed the software. This highlights the importance of having an ICT strategy, regardless of the approach adopted in developing the software.

Tonchovska and Adlington (2012) note that the World Bank had funded land-sector projects in the Europe and Central Asia (ECA) region worth US$1.4 billion, with 56% of the investment in ICT

development and implementation. The ICT systems were developed in the region under a range of strategies:

(a) Locally developed systems by state enterprises in Russia and Turkey,
(b) Large international contracts in Azerbaijan, Bulgaria, Croatia, Kazakhstan, Romania, Serbia, and Ukraine,
(c) Small contracts or in-house development in Albania, Armenia, Bosnia and Herzegovina, Estonia, Georgia, Kosovo, Kyrgyz Republic, Latvia, Macedonia, Moldova, Montenegro, and Slovenia.

These projects have typically been implemented via phased approaches over several years. Törhönen (2016), in reviewing these projects, noted that large international ICT contracts were often difficult to execute and often experienced major delays, and observed that the World Bank's standard project time of five years is too short for the design, tendering and implementation of a large ICT system. It was also observed that in the ECA region in-house ICT system development and incremental approaches had proved easier to implement and that this approach generally provided workable systems that become operational quickly and built in-house capacity. Some recent World Bank procurement of land-sector ICT systems have specified the use of open-source software (see section 4.3.5 for more detail on open source).[6]

The key constraints for the development of large Land IT Systems under the World Bank projects in ECA included the limited capacity of World Bank staff in overseeing the necessary specification and procurement, the limited capacity of governments in specifying, procuring and inspecting the delivery and the strategies adopted by the companies in bidding and delivering the systems. These constraints are still evident in the problems of delivering Land IT Systems under World Bank-funded projects in Azerbaijan and Uzbekistan. A comprehensive Land IT System was specified recently for a large World Bank-funded project in Indonesia. This new Land IT System would have replaced many existing systems, mostly developed decades ago. After careful consideration, the government decided not to proceed with this procurement. While the agency understood the benefits of a new Land IT System, it was unwilling to take the risks of replacing the existing system with a comprehensive new Land IT System. A strategy of making small, but significant, upgrades to the existing system was adopted. Nowadays, the World Bank is more cautious about supporting country client's investments in large, complex ICT systems, although some projects still undertake such investments.

Like other donors, World Bank financed projects have also faced challenges in the development of Land IT Systems in Africa. The challenges in countries in Africa include the expected issues with the cost and difficulties with access to the Internet, unreliable power supply and lack of capacity but there are also more fundamental problems related to political economy, rent-seeking, weak policy and legal frameworks and limited implementation of policy and legislation. With limited success in the past with working with land administration agencies at central and regional levels, some current projects focus on developing systems at local levels that gather and maintain basic land data for local decision making. IT efforts in challenging rural environments remain focused on first registration rather than focusing on longer-term means of recording transactions. These projects are designed to implement a scope of activities that might reasonably be expected to be completed in 5 years. Typically, when these projects are completed, the government seeks support from the World Bank for another 5-year project to address, like all projects, a development objective based on an agreed set of issues. One World Bank stakeholder made the suggestion during the consultations that the best option in Africa might be to focus on improving land markets in urban areas, building strong systems to provide

[6] Two recent tenders that specified open-source software include the Land Information Management System in Malawi and the IISPRC software and hardware supply in Uzbekistan.

efficient land administration services to users and to then scale up these systems to meet demonstrated demand for services in other parts of the countries.

In recent years FCDO (formerly DFID) has been a major investor in land sector projects. These projects have focused on first registration and the development of IT systems to record this data. They include the Land Tenure Regularisation (LTR) Programme in Rwanda and the Land Investment for Transformation (LIFT) Programme in Ethiopia.[7] FCDO has not been a major investor in separate or standalone Land IT Systems but is currently reassessing its approach to land sector programs. FCDO support for land sector programs in the future are likely to look at the whole land administration system, rather than one aspect such as first registration, considering dimensions such as political economy, incentives and the needs of local government and local financial institutions, and the development and linkage of decentralized systems to regional/national systems in a more integrated manner. This new approach might be covered under the topic of "land market services." FCDO also recognizes the need for a much more coordinated if not integrated approach between development partners to facilitate this approach.

After reviewing the experience in the ECA region, Tonchovska and Adlington (2012) list the following key lessons in the development of Land IT Systems:

- Start with the development of an ICT strategy.
- Plan a small 6 to 8-month project for business process reengineering.
- Hardware supply should be separate from the software development, with the requirement for the software driving decisions on hardware.
- Funds for the technical assistance for project and contract management, quality assurance and capacity building should be included in the project design.
- Clear management and reporting mechanisms should be established with senior managers.
- International and national standards should be used to ensure interoperability with external systems.
- Data quality improvement is a long process and should start prior to or in parallel to ICT development.
- The period for using two parallel IT systems and the period of maintaining both manual and digital systems should be planned well and kept as short as possible.
- Sustainability should be a top priority in the design and implementation of the IT system.

The general experience from the major World Bank-funded land projects that were designed and implemented in the ECA region to support the transition to a market economy was that in-house ICT system development and incremental approaches had proved easier to implement and that this approach generally provided workable systems that become operational quickly and built in-house capacity (Törhönen, 2017:26). Recent World Bank procurements of land-sector ICT systems have specified the use of open-source software, although this preference is project based; there is no formal position on use of open-source. There are a couple of key trends in the design and implementation of major land-sector projects. These are:

[7] https://liftethiopia.com/

- The World Bank is more cautious about supporting country client's investments in large ICT systems, in the absence of other related policy and conditions which are more conducive to their institutional and financial sustainability. Some projects are also emphasizing improvements in existing systems.
- There seems to be less appetite in FCDO (formerly DFID) for investing in large programs focusing primarily on first registration and the focus is shifting to a broader consideration of the land administration system as a whole, including aspects such as political economy, incentives and the needs of local government and local financial institutions, and the development and linkage of decentralized systems to regional/national systems in a more integrated manner.

2.3 Is there a role for emerging players in system reform?

A range of actors from the private and nonprofit sectors is active in working with the community of practice and/or government to fill some of the gaps in the protection of property rights.[8] Many of these actors focus on right-holders directly rather than direct support to government, although some have entered into agreements with government. The actors include researchers and universities, innovators developing a range of technology including sensors, data capture systems, mapping, and record management systems, etc., nonprofit, and civil society institutions, philanthropists, and private sector companies.

Examples of innovators include BenBen,[9] an entrepreneurial organization that is setting out to provide land administration and transaction services in Ghana, Medici Land Governance,[10] a company that offers blockchain and other technologies to support land governance, titling, and a secure public record of land ownership, Meridia, a company that offers scalable systematic registration technology[11] and Suyo, a company that offers property formalization services in Latin America.[12] Many of these innovations have been developed to fill a gap in the provision of land administration services by government. The existence of these innovators is encouraging, but they have not been reviewed here in detail as distinct systems or approaches that might be relevant to this study.

Philanthropic foundations have and are funding nonprofit and civil society organizations working on land-sector initiatives. The Bill Gates and Melinda Gates Foundation provided a grant in 2008 to RDI (now Landesa) to scale up a program to provide micro-plots for women in India.[13] The Omidyar Network[14] has also provided funding to a range of nonprofits working on land issues including Asia Foundation, Cities Alliance, Global Land Alliance, Landesa and New America. The Omidyar Network has jointly with DFID funded the development and operations of Cadasta,[15] a low-cost global platform to collect and manage property information, and Prindex,[16] a globally comparative data set on land tenure security. Omidyar Network over the past decade has funded a wide range of land sector

[8] https://www.devex.com/news/sponsored/opinion-5-innovations-to-tackle-property-rights-90226

[9] http://www.benben.com.gh/

[10] https://www.mediciland.com/

[11] https://www.meridia.land/

[12] https://www.suyo.co/

[13] https://www.gatesfoundation.org/Media-Center/Press-Releases/2008/11/Secure-Land-Rights-to-Help-Women-Achieve-Food-Security

[14] https://www.omidyar.com/

[15] https://cadasta.org/

[16] https://www.prindex.net/

activities. These activities include new models for property rights delivery, the development of technology for geospatial data, data capture, rapid mapping of informal urban settlements and agricultural smallholders, the creation of platforms and benchmarks, and significant land-sector research and journalism. Early in 2020, Omidyar Network announced the launch of PlaceFund,[17] a new nonprofit that would take over the portfolio of Omidyar Network land initiatives and continue to focus on addressing the issues of insecure property rights, unstainable land use and climate change. [18]

Private sector companies have also funded land-sector projects. Large agribusiness and food production companies have funded activity to record and secure land rights of their suppliers. One of the case studies on Meridia's webpage is a project to document the land holdings of 47,000 cocoa farmers in Ghana which was funded by Mondelez International, a major snack food company.[19]

These new players in providing land-related services and technologies have arisen to fill a gap that is not being addressed by government. The procedures and tools on offer have relevance in addressing the problems in many countries where donors have or are likely to have a land sector project but would only be sustainable in an arrangement that has the support of government. It is important to note that there are alterative procedures and tools that are available, including the open-source tools MAST, Open Tenure and STDM (see Table 5) but these systems require some local capacity and resources to be sustainable.

[17] https://www.omidyar.com/blog/announcing-placefund

[18] The portfolio of land projects being administered by PlaceFund is listed on https://placefund.org/partners/.

[19] https://www.meridia.land/cases/mondelez

3 Unique challenges in low income/lower middle-income countries

The low-income and lower middle-income environments in which MCC and other development partners work present unique challenges. These challenges are discussed in the following sections and include:

- the policy and legislative frameworks
- the institutional context
- demand and user incentives
- the technology enabling environment
- operational factors

It should be noted that even within low income and lower middle-income countries, there are geographic areas and contexts – often rural environments – with even further limitations and this requires particularly thoughtful decision-making on key aspects such as tools for record-keeping and future transaction management.

3.1 Policy and legislative frameworks

Policy and legislative challenges are found across international, national, and sub-national levels. At national and sub-national levels, the existing legislative framework may be a barrier to Land IT Systems reform, particularly the adoption of new tools or processes. The following provide some of examples of why and how this occurs:

- Laws may not record all tenure in the country, particularly excluding the recording of customary tenure and changes in customary rights over land.
- Laws may exist but require change: such as with legal recognition of digital data and the primacy of digital versus manual records. Similarly, the legal framework may be fragmented, with overlapping and sometimes conflicting laws.
- Laws may exist but be overly prescriptive, or limit technology options: accuracy specifications may be overly onerous, data storage outside the country may be prohibited, or data standards may exist but be impossible to implement at sub-national levels.
- Laws may not exist, for example, to enabling digital signatures to be used as part of online systems, to authenticate digital data and transactions, or to address privacy and security concerns, and there may be no data standards, etc.
- Coordinating (and ideally streamlining) efforts across differing legislative environments at both national and sub-national levels may be difficult, including understanding and accounting for an increased complexity of actors and interests.

Additionally, policy frameworks (or their absence) may be a further barrier to Land IT Systems reform by encouraging siloing of information and not adequately enabling (and in some cases, compelling) cooperation and data sharing between government entities. Many countries are still only beginning to institute national spatial data infrastructures (NSDI) and similar frameworks for managing spatial information. The absence of such policy infrastructure (including guiding documents and protocols on appropriate data management, data standards, data pricing, privacy, and metadata) can limit reform success and sustainability. Countries which lack a comprehensive policy on ICT, or a clear roadmap for the future growth and implementation of ICT will likely struggle to implement and maintain Land IT System reforms and investments.

Legally recognized identity is fundamental to the recognition and registration of property rights in most legal systems and individuals who do not have documented identity are usually not able to hold property rights in formal systems. This is often a problem for women, the poor, and rural populations, where civil registries are not readily accessible, and people often lack the ability to produce birth certificates. There also can be concerns about privacy and data security. These three topics of identity, privacy, and data security are briefly discussed below, with specific attention to the likely risks, opportunities, and future needs of LIC/LMIC.

3.1.1 Identity issues matter

Identity information serves as critical national infrastructure, providing the basis for citizenship (voting, mobility), planning, service provision and access, fiscal management, census, and border security (USAID, 2017). Identity is a critical factor in the successful implementation of land information and transaction systems as it allows the establishment of a link between land parcel spatial data and the rights of the person holding that land parcel. That identity remains a global challenge is clear by the 1.1 billion people estimated globally to be living without any identity document (ID), with 81% living in sub-Saharan Africa and South Asia, 63% living in lower-middle income economies and 28% living in low-income economies (World Bank, 2018). The figures also show a significant gender gap, with men more likely to have an ID than women. Furthermore, whilst 68% of the world's population is included in a country's ID system, these systems vary widely in the services they offer, and few countries have a singular ID system universally linked to services (USAID, 2017).

A number of donors and other stakeholders have identified digital identities as a game changer, enabling countries to leapfrog to more efficient, modern, and automated systems. A digital ID platform utilizes biometric data, digital databases of identity data, digital credentials and draws on growing mobile phone adoption (World Bank, undated). However, criticisms include that systems can be costly to setup and maintain, are often siloed, and can exacerbate the 'digital divide' by solidifying existing exclusions. Systems must have clear privacy and security mechanisms in place – which is a clear entry point for blockchain and other decentralized information storage solutions. Clear opportunities lie in drawing on private-sector solutions (building on state-sponsored digital identity systems, as demonstrated in India's Aadhaar system) and algorithmically deriving ID verification (potentially linking with Land IT Systems). Ultimately national identity and/or population registers can provide a key base of information, and countries may be able to draw on key database and IT expertise in these agencies, as well as the datasets themselves, as the basis for an NSDI and Land IT System reform. Land IT System designs should have regard for existing identity databases and responsibilities, and design for interoperability without duplication – the use of key registries is commonly adopted to do so.

3.1.2 Addressing concerns about privacy

Privacy concerns related to Land IT Systems investments in developing countries arise from digital reforms if access to personal information is not well controlled and safeguarded. Internationally, governments have been impacted by increasing data quantities, data access and technology adoption. These changes increasingly require policymakers to review and update measures that build user trust, facilitate data protection, and ensure data privacy.

There is an identified lack of research on information privacy practices in e-government in developing countries, particularly in Africa (Mutimukwe et al. 2019) and less than half of all countries in Africa have adopted the appropriate legislation for data privacy protection (UNCTAD, 2019a). Challenges identified include inadequate enforcement of privacy obligations, inability of authorities to keep pace with technology advancement and insufficient public awareness of privacy risks (UNCTAD, 2019b). Further data protection challenges stem from increasing mobile device use (including in the collection of land ownership data), risks of devices being compromised, and limited consumer/public awareness, trust, and uptake of e-government services.

Developing countries also face challenges associated with both too little and too much regulation. On the too little side, the growth in the use of smart devices alongside limited capacity for planning, oversight, regulation, and enforcement, carries the risk of exposure to fraud, cybercrime, and data/identity abuse. Conversely, a number of developing countries have adopted cyber-sovereignty measures that create data flow barriers, including legal requirements to store data and locate data centers within a country's borders, as well as regulations that restrict the ability to move and process personal data across borders.

For the moment, the high costs of additional international bandwidth to access overseas servers and data centers and the challenges in achieving adequate connectivity performance limits the uptake of cloud services, particularly at sub-national levels. For data privacy, this slower pace of cloud service uptake (in Africa, at least) provides a limited window of opportunity to design and put in place sound data privacy protections, policies and systems, drawing from 'frontrunner' developed country mistakes and good practices. The UNCTAD Digital Economy Report (2019) identifies a number of legislative requirements to address gaps, including data regulations to ensure the rights of individuals, to forestall the risk of personal data being stolen or breached, to identify when user/customer consent to personal data collection is required, and to set limits on what can be collected and how it can be used (UNCTAD, 2019b). The UNCTAD report further identifies the European Union's General Data Protection Regulation (GDPR) as the most comprehensive approach to data protection to date. There is some interest for the GDPR to become a global standard (including adoption by global digital platforms). In addition to watching and drawing lessons from GDPR implementation, though, the Regulation has further potential flow-through impacts to developing country e-governance initiatives, as it is applicable to all data on European Union citizens. This may have relevance for developing countries that have colonial histories.

3.1.3 Mitigating data security risks

Above and beyond issues of privacy and confidentiality, data security extends across protecting information and information systems through the preservation of:

- Confidentiality: ensuring information can be accessed only by those authorized.
- Integrity: safeguarding information accuracy, completeness, and processing methods.
- Availability: ensuring the access of authorized users when required.

Data security risks arise from cybercrime, fraud, viruses – whether malicious or inadvertent – and loss through physical infrastructure and/or paper records damage (e.g. resulting from disasters) or simple negligence, illegal alteration, or theft. The threat of cybercrime is estimated at US$3 - 6 trillion annually (Cyberventures, 2019).

The risks are not solely financial. Website hacking can result in loss of reputation and trust whilst system failures can compromise the integrity of entire datasets. Similarly, the threats are not purely external. Whilst data security threats may arise from external (and malicious) third parties and increasingly complex and effective hacking tools and viruses, significant (and far more common) threats may also stem from low staff (and user) awareness of security measures and risks, increasing system complexity (including increased networking and distributed computing), inadequate backup of information resulting in data loss, and the increasing threat of natural disasters.

Data security threats may also be less visible, and linked to a lack of integrity, reliability, or appropriate access. The barriers that the high cost of bandwidth in Africa bring have previously been mentioned. The lack of redundancy and vandalism also remain concerns for reliable service provision. Efforts to improve 'last mile' domestic connectivity, such as Google's Project Link (now under the banner 'CSquared' – csquared.com), and a growing number of locally based data centers and server providers will address some redundancy concerns and should reduce external integrity and reliability threats in the future.

To mitigate data security risks, possible measures include:

- use of firewalls to ensure data center security,
- use of anti-virus and anti-phishing tools, alongside user training and awareness to promote website security,
- data encryption,
- clear processes and restrictions to help ensure physical and soft infrastructure security (such as restricted access, documented workflows with redundancy as required, regular auditing, etc.),
- offsite and regular data backups to mitigate against data loss in the event of a disaster,
- credible threat of punishment established by investigation of security breaches and subsequent punishment.

Different Land IT System approaches may have different data security risks. For example, public-private partnership (PPP) models may have different risks compared to in-house development, similarly large and complex projects with significant legacy data and software will have different risks compared to smaller, single component projects.

A clear challenge of addressing data security lies in the lack of commonly accepted data security practices, the capacity of partner governments to implement data security measures in the first place and then to keep current with the quickly changing environment, and the increasing threat of disaster impacting many developing countries. As a minimum, there is likely to be a need for further training in data security, which would be implemented as part of Land IT System reforms.

3.1.4 Critical policy and legislation considerations

Decision-making tools on Land IT System investments will need to consider the policy and legal frameworks at a high level, focusing on:

- the tenure recognized,
- the legal recognition of digital data and signatures,
- existing personal identity and legal entity registration databases and systems and their linkage to the existing and possible future Land IT System,
- the provisions and practices for information privacy in e-Governance and provision of land services,
- the policy, legislation, practices related to data security, including the aspects of confidentiality and integrity, and
- access and procedures for NSDI, ICT and e-Governance.

3.2 Framing the institutional context

The institutional environment provides the platform for implementing Land IT Systems. Key challenges arise from institutional complexity, institutional capacity, and organizational behavior change. LIC/LMIC may experience challenges due to:

- Strategic challenges in determining how best to deliver key land services and maintain data, which is a basic requirement for the formulation of clear policy on land administration.
- Bureaucratic complexity and fragmentation, arising from multiple levels of government from national to state to municipality to village; the devolvement of different land administration

responsibilities to different levels of government; and multiple institutions managing land with often conflicting mandates and with siloed approaches to data management. There is a need to be responsive to a mix of institutional structures addressing the various needs of cadastre, rights registry/ies, fiscal data (values, tax, etc.), etc.

- Obstacles/reluctance to share/exchange data among institutions, and between institutions and the private sector.
- Existing paper-based systems that may be incomplete, inconsistent, and reliant on inefficient procedures and limited public participation in recording property transactions, with significant effort and cost required to address challenges with the paper system prior to any further reform or new technology introduction.
- Mixed and/or low levels of political willingness to change from key policy institutions and leaders. Countries may also have significant levels of clientelism and rent-seeking providing significant barriers to reform. Similarly, partner countries have many other challenges against which Land IT System reform must compete for funding/capacity.
- Limited human resource capacity, including insufficient numbers of personnel (and/or sufficiently skilled personnel), difficulties in recruiting and retaining key staff at city and regional offices, and inadequate pay-scales to retain staff (often leading to loss of trained staff to the private sector).

Tools for decision-making on Land IT System investments will need to consider the institutional context for the provision of land services, including the political will for reform, bureaucratic complexity across sectors and through levels of government, obstacles for data sharing and exchange, geographic coverage of existing records systems, status of existing records (both paper-based and digitized), and human recourses and capacity.

3.3 User demand and incentives for participation

It is impossible for any Land IT System to be sustainable without significant uptake among users, including both officials charged with using land administration IT systems for service delivery and the public who may interact with an IT-based system. Challenges that may impact on service uptake include:

- Low awareness of Land IT System benefits, functions, and the need to register property rights and transactions in these rights (particularly where informal systems are strongly entrenched).
- A large proportion of landholders/users do not perceive a need for the services or perceive that the costs outweigh the benefits of registering property transactions.
- Low IT literacy in general, limiting public ability to access online and digital service delivery.
- Public distrust and possible hostility, where Land IT System functions have been in place, but have been misused, or are unreliable.
- Improving service provision, promoting efficiency, transparency and a ‘service culture’, potentially with incentivization for individual or private-sector inputs.
- Increasing access for vulnerable groups including gender, minority, and indigenous peoples, to land and decision-making, their awareness of Land IT System services and access to these and identifying and removing legislative and/or procedural barriers to participation.

- Growing the demand for services, particularly approaches that may involve public willingness to pay fees for services and/or private-sector opportunities to provide value-added services to achieve financial sustainability.

Tools for decision-making on Land IT System investments will need to consider the demand for services and the incentives for participation in the land administration system, including public awareness of policy and laws, IT literacy, level of public trust, access generally and by vulnerable groups, and evidence that demonstrates that there is a demand for services.

3.4 Technology environment to facilitate reform

The technology enabling environment includes the core infrastructure – both physical ('hard') and 'soft' – necessary for technology implementation. Much of the technology enabling environment has been addressed in other publications, notably the joint FIG-World Bank Fit for Purpose Land Administration report (Enemark et al. 2014, 2016). An important point to make is that technology can be a strong motivator for reform and may even 'force' necessary reforms for the better. So, whilst "fit-for-purpose" principles should be promoted, significant opportunities exist for developing countries to 'leapfrog' technologies, and sometimes direct implementation of best practice technology may help foster political will, raise up implementation champions, and fast-track user adoption.

Challenges that may impact the implementation of technologies include:

- Availability of sufficient 'know-how' to oversee and maintain Land IT System reform efforts.
- Appropriate maintenance and planning, including redundancy, repairs and replacement and understanding of information system update cycles. Establishing a culture of maintenance, including adequate budget line and capacity, is important but often underestimated.
- Planning for interoperability and system-wide implementation, including participatory design processes and multi-purposing.
- Availability of key hardware components, including an adequate supporting environment (such as adequate cooling, space, backup, etc. for servers), reliable and affordable power sources, and reliable and affordable Internet connectivity.
- General comfort/ease of ICT adoption within the economy and government, including willingness to adopt a pragmatic approach to technology, e.g. following "fit-for-purpose" principles.
- Understanding of gender and social inclusion issues related to technology, such as barriers to access, ensuring a diverse workforce, and rural/urban dimensions.
- Adoption of appropriate processes and policies/legislation, e.g. regarding system and data security, and data privacy.

Several technologies facilitate an enabling environment for investment in Land IT Systems. Table 1 briefly addresses these technologies across themes of reliability, comprehensiveness, access, and security, with a focus on likely positive and negative short-term impacts to Land IT System reform in LIC/LMIC. System reliability is paramount and system designs should ensure sufficient redundancies, e.g. to counteract power and networking outages. Emerging trends such as mobile device proliferation, authentication of land administration transactions, and land information with digital signature and measures to safeguard Land IT Systems from external threats are at varying levels of maturity, hence partner countries need to be aware of the specific prerequisites that need to be in place prior to considering adoption of these trends.

Table 1: Enabling environment considerations for Land IT Systems

System reliability	**Internet connectivity**	+ Allows for a single, centralized server + Facilitates nationally consistent client services and data quality + Allows for simplified system infrastructure at decentralized local offices - Requires additional risk mitigation planning for malicious threats, internal user errors, down-time and system upgrading - Requires infrastructure in place and/or additional time and costs to install and maintain infrastructure (including mechanisms to address any rural-urban or other divides)
	Power supply reliability	+ Facilitates business continuity of land administration agency + Minimizes the need for cumbersome alternative processes and infrastructure when power supply is interrupted + Potential environmental and financial benefits arising from use of solar energy generation (where implemented) - Power supply interruptions significantly threaten system sustainability, efficiency, and data integrity - Need budget to cover the costs of power for servers, computers, and associated equipment such as air conditioning and fuel for backup generators
	Cloud servers and cloud storage	+ Emerging number of companies offering software-as-a-service, allows computerized land administration services to be provided in locations where there is limited or no in-house system support capacity + Remote data storage accessed via a cloud server best facilitates 'anywhere access' and disaster recovery through automated back-ups and easy restores + Typically, low cost, secure and scalable, with support easily outsourced + Cloud storage can be good for first generation[20] IT systems in tough environments, by providing a simple means for offsite database and file backups - Internet connectivity is required - Many countries will require remote servers to be located nationally – may be problematic as not all countries have servers, may increase cost by reducing available suppliers - Can mean fixed and ongoing contracts - State may not be comfortable with external control of data (i.e. by a private entity providing the cloud server)
System comprehensiveness	**Faster, more accurate geographic positioning/ mapping**	+ More options to gather data, e.g. through a wide range of Global Navigation Satellite System (GNSS) receivers (smart phone – survey grade dual band GNSS receivers) and more GNSS satellite constellations, automated feature extraction, etc., allowing for "fit-for-purpose" data collection that is rapid and low cost + Increases efficiency and lowers cost of systematic registration + Facilitates recording of cadastre changes and promotes cadastre integrity

[20] First generation means the first product or technology of a particular type to be developed.

		+ Facilitates digital lodgment,[21] process automation and rules-based validation and process control (that are applicable to all Land IT System supported land administration transactions, not just spatially related transactions) + Wider map coverage and more consistent spatial data - Professionals can push for higher accuracies that may not be "fit-for-purpose" - May highlight boundary discrepancies and cause conflict where none existed previously
System access and interoperability	**Mobile device proliferation**	+ Mass adoption of mobile devices (in particular smart phones with greatly extended functional capabilities) accompanied with competency in the use of mobile device software applications greatly facilitates participatory and crowdsourced tenure recording and mapping, as well as customer access to land data + New remote channels to access land administration services - Exacerbates existing digital divides - May increase data security risks
	Technology access	+ Many technology options available to facilitate efficient, reliable, and low-cost land administration service provision + Enables interoperability between agencies, and with public sector + Enables value-added services to facilitate financing, enables software-as-a-service - Requires increasingly technically qualified staff; staff capacity, adequate training and retention can be challenging - Technology maintenance and upgrading can be difficult to keep up to date and plan and cost for - Many developing nations will need hybrid or offline approaches to reduce system downtime and/or appropriate back-up measures
	NSDI/fundamental datasets[22]	+ Secure, read-only access to data held within land administration database(s) impacts on the design of Land IT Systems + NSDI can provide a remote online channel to land administration services - Can take time to establish, especially if siloed institutional practices are well-established
System & data security	**Authentication of land administration transactions and land information with digital signature**	+ Facilitates digital lodgment of land administration service requests + Reassurance to users that they are dealing with authentic and authoritative land information + Can be a more rigorous form of Land IT System user authentication - Law change to legally recognize digital signatures takes time - Added ongoing expense to the land administration agency and certain external users to obtain and renew digital signature service

[21] Electronic lodgment of title transactions (may also include digital lodgment of cadastral survey data). Also comes under the banner of "e-conveyancing".

[22] An early deliverable from a national spatial data infrastructure is improved access to several "fundamental datasets" such as the current cadastre map. Other such datasets can include land registers and other public registers.

	Digital archive of land administration records	+ Digital backups regularly and frequently updated and stored off-site provide for timely recovery of service following any disaster + Digital archive of land records facilitates measures to minimize the risk of improper modifications to land transaction records - Law change to recognize the legal validity and authority of scanned images of historic and new land transaction takes time
	Measures to safeguard Land IT System from local threats	The operation of a Local Area Network (LAN), not necessarily connected to the Internet is an essential feature of many Land IT System, and measures to protect the system include regular database backups, the use of anti-virus software, and acceptable user practices. + Utilizes well known practices and easily available software to implement adequate measures to safeguard the operation of a Land IT System - Requires technically capable staff who stay up to date on relevant technology developments - Additional expenses will be incurred to implement safeguard measure
	Measures to safeguard Land IT System from external threats	Where a Land IT System is implemented on a network with Internet connectivity additional safeguard measures are required to combat cyber security threats + Standard measures available to minimize these risks - Requires a higher level of user care and compliance with acceptable practices by land administration staff and a commitment by the land administration agency to maintain this capability - Land IT System software must be updated regularly to resolve any newly identified vulnerabilities in the Land IT System software
	Blockchain	Blockchain is the technology underpinning Bitcoin involving a chain of ideally decentralized data that has been time-stamped and secured by cryptology. To be applied in a land administration registry environment, 7 prerequisites have been identified:[23] 1. Registries should be as accurate as possible 2. Registries must be digitized 3. An identity solution is required 4. Multiple signature wallets are in place 5. Use a private or hybrid blockchain 6. Registries have Internet connectivity 7. Training of professional community that interacts with registries. As few, if any, of these prerequisites are likely to be met in future MCC partner countries, blockchain is only applicable in a Land Administration as a Service (LAaaS) implementation or in future, subsequent generations of Land IT Systems.

[23] Graglia & Mellon, 2018. "Blockchain and Property in 2018: At the End of the Beginning". World Bank 2018 Conference on Land & Poverty.

Tools for decision-making on Land IT System investments will need to consider the technology environment, including the availability of skilled ICT resources in the country, government and the land agency, budget and expenditure on ICT maintenance and consumables, and level of computerization in government.

3.5 Operational challenges to reform

Countries where MCC is considering investing in Land IT Systems have likely already experienced challenges in establishing, implementing, and maintaining such systems.

Many of these previous Land IT Systems investments may no longer be used or are now only operating sub-optimally because of a wide range of factors. Some of the more obvious operational factors contributing to this situation are:

- poor infrastructure (reliable power, Internet connectivity, fragile interoffice wide area network connectivity),
- IT competency and confidence among land agency staff who have been expected to perform key roles using and maintaining the Land IT System,
- system complexity inappropriate to the available expertise of users and the land agency office conditions,
- harsh office environments lacking air conditioning and physical security for servers and other computing equipment,
- insufficient operating budget for computer consumables and repairs,
- poor management practices, unmotivated staff, and a lack of “client focus” within the land agency,
- dual processing of land administration services involving both the traditional paper-based processes as well as the Land IT Systems based processes leading to increased land agency office workloads and confusion over the location of key land records,
- no commitment or funding for completing the digitization of key “active” land records for each land agency office,
- declining quality of digital records held in Land IT Systems (including those resulting from first registration) sometimes because of limited enthusiasm for subsequent registration and in other times because the Land IT System lacks appropriate functionality.

Tools for decision-making on Land IT System investments will need to consider the factors impacting on the effective and sustainable operation of the Land IT System including the identification of how any such risks should be mitigated.

4 Technology trends in Land IT Systems

There are several technology trends within Land IT System design that have emerged in recent years across elements of software, hardware, connectivity, system operations and maintenance and the application of the Total Cost of Ownership model. These trends have and/or will impact the design of new Land IT System solutions and, where appropriate, advice is provided on how these new features should be incorporated in these designs. New technologies and trends require governments (and development partners) to consider specific decision points prior to system reform and new technology uptake. The following section discusses these new technology trends, with the underlying assumption that governments are seeking to take advantage of the benefits arising from the adoption of new technologies in Land IT Systems and are committed to and/or implementing strategies to strengthen e-Governance.

4.1 Emergence of Land IT Systems

4.1.1 Technology and land administration services

The first computerized systems in land administration appeared in land administration agencies in the 1970s and were typically finance systems running on mainframe computers that in some cases were expanded to include rental collection and management of leases of government land. As personal computers (PCs) became available, they became the preferred office survey calculation tool. Similarly, in government mapping agencies larger computer mapping systems were purchased (or in some cases developed) although their use tended to mirror the existing map production processes.

Interest in Land IT Systems increased in the early 1980s, in part arising from the availability of commercial GIS software (from companies such as ESRI and Intergraph), the research of certain academics exploring the potential of Land IT Systems and associations such as URISA promoting the use of GIS. The concept of "multi-purpose cadastre" (National Research Council 1983[24]) encouraged a wider view of computerized land systems from just being a computerized mapping system displaying property boundaries. The Maritime Land Registration and Information Service for the Canadian Maritime provinces was one of the first implementations of a land information system – involving a mainframe computer and a monolith system (Roberts WF, 1978[25]). Other implementations of land information systems occurred throughout the world in the 1980s and early 1990s most of them being in-house or out-sourced developed bespoke monolith system developments with some of them using commercially available GIS products to provide the spatial functionality where this functionality was deemed necessary.

By the 1990s, PCs, usually linked to local servers on the same local area networks were widely used in land agencies along with GIS, DBMS and software development packages that were no longer only available on large, expensive mainframe computers. In some cases, this resulted in a proliferation of computerized systems of "home-grown" developed systems supporting certain aspects of land administration processes (e.g. cadastral mapping, computerized indexes to replace card indexes to deeds and titles, etc.). In parallel, commercial vendors of GIS software and document management systems were offering "off-the-shelf" and customized versions of their software as providing Land IT

[24] Nation Research Council 1983. "Procedures and Standards for a Multi-purpose Cadastre", Panel on a Multipurpose Cadastre, Committee on Geodesy, Assembly of Mathematics and Physical Sciences, National Academy Press, Washington DC.

[25] Roberts WF 1978. "Report on land registration and information service, Maritime Provinces, Canada". Proceedings of the 2nd MOLDS Conference, Washington DC.

System solutions. There were also examples of consortia (including those involving multi-national IT companies) offering PPP solutions typically for computerized land registration services.

By the mid-1990s, the ease of access to the internet, the ability to network through the use of virtual private network (VPN) and digital signatures opened up opportunities for governments to move away from paper-based land administration processes and towards digital transaction processing including digital submission of applications for land administration services. A leading example of this was the New Zealand Landonline system that has resulted in New Zealand's high ranking in the World Bank "Doing Business" survey in the Registering Property category for the past 15 years.

4.1.2 The modernization of land agencies

Evolving societal expectations have also impacted the design of Land IT Systems. Governments and citizens are now more likely to challenge and question the performance of state agencies including land agencies. Many governments have state sector agency reform programs where the state sector agencies are re-organized, encouraged to work cooperatively ("whole-of-government" approach), and also encouraged to use technology to be more effective and efficient. The State's historical involvement in providing certain services has also been reviewed to see if they should continue to be provided by the State and, if they are, what is best the means of service delivery. In LIC/LMICs with a colonial history this review is particularly pertinent as many land administration systems date from the colonial era and were originally designed for the convenience and advantage of the former colonial power.

Citizens have also become more sensitive to the transparency associated with the operations of state sector agencies, the protection of an individual's privacy and, in the case of private-sector involvement in land administration processes (e.g. cadastral surveying, property valuation etc.), how the State's responsibilities are still met and reassurance that public interests are being protected.

4.2 Reviewing the trends in Land IT System development

Since 2000, there have been some clear trends in technology that are relevant to the design and approach to developing Land IT Systems. These trends include:

- There is no clear trend in the software development option (in-house development, bespoke development, Commercial, Open Source, Configuration, Customization, or Land Administration as a Service) with investment choices being made on a case-by-case basis
- The Agile approach to software development and customization seems to be the best, provided there is close involvement by the land agency, good training in the methodology and compatibility with the procurement arrangements
- The most relevant form of software architecture for Land IT Systems in LIC/LMIC is Service Oriented and with Microservices architecture where an existing Land IT Systems is being upgraded
- LADM compliance is becoming common practice
- Cloud-based solutions show tremendous potential but the lack of reliable and affordable internet connectivity in LIC/LMIC currently limit their use
- Interoperability with other systems related to Land IT System is increasingly considered good practice and can been facilitated by adherence to a number of applicable standards
- Blockchain protection is not relevant unless there is continuously reliable internet connectivity, together with other pre-requisites that are not in place in LIC/LMIC.

These and other trends and descriptions of how these technologies could be applied in Land IT Systems are set out in the following sections.

4.3 Moving beyond traditional paper-based land administration

4.3.1 Options for software architecture

Software architecture refers to the fundamental structure of a software system. The form of software architecture implemented has changed significantly in the past two decades, primarily in response to advances in computing power, increased system complexity, emerging approaches to software development, Internet accessibility, and the emergence of cloud-based servers and services. Table 2 describes the dominant (current and historical) software architecture models and the advantages and disadvantages of applying these in the context of Land IT Systems.

Drawing on this table, and with respect to the development of Land IT Systems in LIC/LMIC, factors that will influence which type of software architecture is adopted will include:

- Availability of reliable **Internet connectivity**,
- **Degree of existing computerization** within the land agency and whether the Land IT System is a first or subsequent generation/iteration,
- **Degree of interoperability** that needs to be provided for (for instance the national e-government framework),
- **Likelihood of further services** to be provided by the Land IT System soon,
- Availability and affordability of **suitably skilled software developers**,
- **Maturity of emerging models of software architecture** such as "serverless" computing[26] that today are not mature, but in the future may be more viable,
- **Software development complexity** (being both the complexity of system design necessary to meet the identified business needs of the Land IT System, and the need for different specialized software development skills) for both initial software development and subsequent software support, maintenance and enhancements.

Considering the factors impacting on the choice of software architecture and the different forms of software architecture described in Table 2 it is likely that Land IT Systems in LIC/LMIC would select Service Oriented Architecture (SOA) as the preferred architecture for first generation systems.

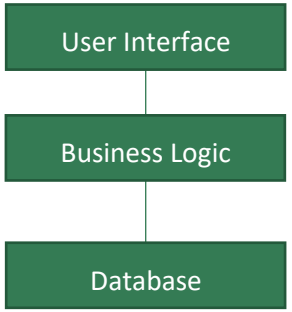
SOA better accounts for the likely level of complexity necessary for robust and comprehensive Land IT Systems, and the likely future scale-up. There is less software complexity and it is more likely that suitable local software expertise will be available, and there is no reliance on Internet access.

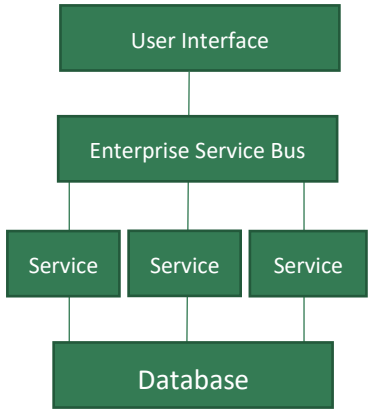
Second or later generation systems, may, however look to microservices architecture for the modernization of existing systems, as these have the potential to be more efficient (particularly in executing new releases), can capitalize on a better understanding within the organization of the potential of the Land IT System to deliver land administration services, and are likely to be more robust as systems develop.

The appropriateness of serverless architectures should, however, continue to be reviewed pending maturity of emerging alternatives and partner country context (e.g. access to Internet and the availability of IT supplier services with experience in serverless architectures).

[26] Serverless computing is a cloud computing model in which the cloud runs the server and manages the allocation of machine resources, https://en.wikipedia.org/wiki/Serverless_computing

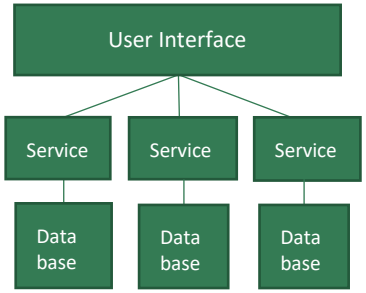
Table 2: Software architecture models

Type of Software Architecture	Advantage/Disadvantages	Diagram[27]
"Traditional" Monolith (sometimes referred to as "3-N Tier/Layer" architecture) where software is designed as self-contained components (being organized in tiers/layers) that are **interconnected** and **inter-dependent**. The architecture has 3 layers: • Presentation Layer (the user interface and how the system is "presented" to users) • Business Layer (incorporating business rules and logic) • Data Layer (based on a data model and database schema)	Advantages: • Software development teams can quickly and simply create, prototype, and deploy new systems to production. Software developers need only general development skills and can be utilized across any software development task using the same Integrated Development Environment (IDE). Common software elements are encountered across current and previous development projects • Architecture is clearly understandable by all members of the software development team (because teams consisted of software developer generalists with only minimal, if any, specialized expertise) • Encourages software code reuse (which was considered good practice in terms of minimizing the amount of code written and ensuring the efficiency of the code which in turn impacts on software performance) • Facilitates Land Administration Domain Model (LADM) compliance as a consistent foundation for future software extensions and the adoption of international best practice • Can have better performance than e.g. microservice architectures, due to reduced memory load Disadvantages: • Inherent application interdependencies force significant reworking as new functions are added • No or limited, often cumbersome connectivity, to other systems • Scalability can be an issue, especially when the number of concurrent users increases significantly and where there is heavy use of segments of code (through software code reuse) and these segments of code are modified to handle new functionality • More difficult to update, due to the above disadvantages	

Type of Software Architecture	Advantage/Disadvantages	Diagram[27]
Service Oriented Architecture (SOA) (Monolith) • Still monolithic, SOA involves the deployment of 'services' – discrete modules that perform a required function and can easily be reused. • It does not need to conform to the 'three-layers' of the traditional approach above but does utilize the same principles of 'reuse'[28] of software procedures as used in Traditional 3-N tier Monolith.	Advantages: • Adoption of SOA protocols facilitates inter-software application links and communication – e.g. to make data available to NSDI • Self-contained and loosely-coupled nature of 'service' functional components enable reuse without the same level of interdependencies present in traditional monolith approaches – since each software service is an independent unit, updates and maintenance do not have the same capacity to hurt other services • More reliable for larger systems than traditional monolith and enables parallel development since services are independent Disadvantages: • Largely as above – the architecture remains complex and can be difficult to manage • Requires significant upfront investment • Places extra load on the system than traditional monolith, as all inputs are validated before one service interacts with another.	

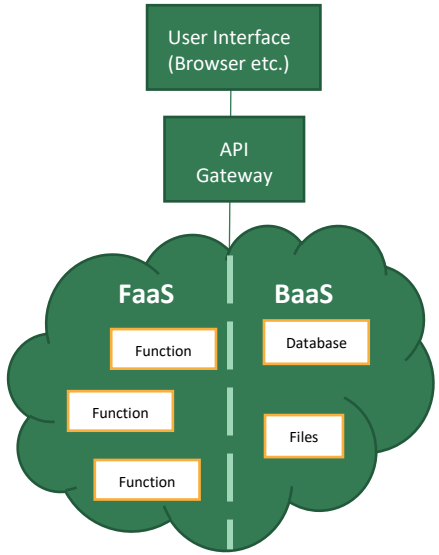
[27] Diagrams guided by https://rubygarage.org/blog/monolith-soa-microservices-serverless (accessed 17th February 2020)

[28] **Software code reuse** is the practice of using the same software code for multiple software procedures and functions.

Type of Software Architecture	Advantage/Disadvantages	Diagram[29]
Microservices • Collection of small, autonomous services of interest that can be individually deployed. • Involves a series of uniform and predefined (stateless) operations. • Functionality delivered via an Application Program Interface (API) • Utilized to modernize existing monolith systems	Advantages: • Enables system modularity that facilitates code development, making it easy to test and deploy, and increasing agility • Developers can work on their services independently and quickly • Service decoupling, which can enable efficiency • Better allows for scale up, especially with multiple users Disadvantages: • Much more complex to develop, requiring significant planning, team resources and skills. Software developers will need to be much more specialized[30] to deal with this complexity and these skills may not be readily available (and/or taught) in MCC partner countries • Use of Application Programming Interfaces (APIs) can increase security risks • Inter-service calls (communication between the modules providing autonomous services) can contribute significantly to network latency	

[29] Diagrams guided by https://rubygarage.org/blog/monolith-soa-microservices-serverless (accessed 17th February 2020)

[30] e.g. requiring architecture knowledge specific to microservices, frameworks knowledge (e.g. Spring Boot, Spring Cloud), container knowledge, domain modelling expertise, back-end development expertise, security knowledge, etc.

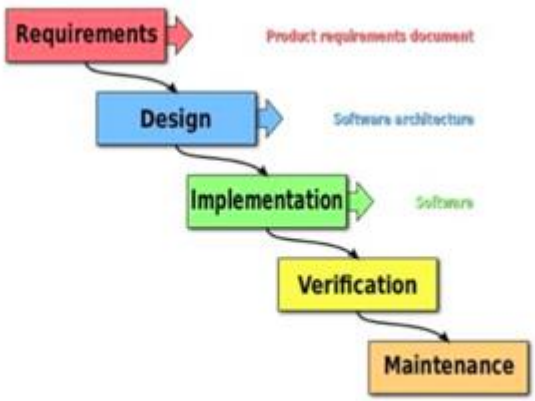
Type of Software Architecture	Advantage/Disadvantages	Diagram[29]
Serverless Cloud computing approach where code execution is managed by a (third-party, cloud) server. Incorporates: • Function as a Service (FaaS), where developers upload discrete units of functionality and these are executed independently. • Backend as a Service (BaaS), where developers outsource backend aspects (including database management, cloud storage, hosting, user authentication, etc.) and these are priced on an execution basis. • Client-side logic, which triggers certain functions.	Advantages: • Reduced cost (but potentially varying month to month depending on the number of function calls and associated server resources expended, so there is potential greater uncertainty in budgeting) • Facilitates agile development because of faster setup and turn-around of software releases • No system administration and easier operational management • Disaster recovery risk is reduced through being managed by the cloud provider who has specialist expertise in maintaining IT infrastructure Disadvantages: • Immature technology in terms of no standard application protocols to deliver serverless services and few land administration serverless services are thought to be available. (Generally, there needs to be a community of developers developing such services before standards are developed and the technology is considered "mature".) • Land administration service provider has reduced overall control of the software • Client access is exclusively through private Application Programming Interface (API) (rather than open protocols as in microservices applications) • Architecture is quite complex, which may require additional in-house skills, or complete outsourcing (and hence 'trust' of private sector providers) • Depends completely on being connected to the Internet • Function execution duration is capped (i.e. there is the risk of a "hard" timeout)	

4.3.2 Methodologies for software development

There are numerous prescribed methodologies that can be followed to write software code and build a database to implement a system design that will include the specification of a specific software architecture.

A traditional software development approach follows a "Waterfall" methodology, with relatively regimented phase progression and minimal feedback (see Figure 1).

Figure 1: Waterfall software development methodology



By Peter Kemp / Paul Smith (Adapted from Paul Smith's work at wikipedia) [CC BY 3.0 (http://creativecommons.org/licenses/by/3.0)], via Wikimedia Commons

Although simple to understand, the Waterfall methodology involves significant early design effort to resolve complex design issues. From the perspective of Land IT Systems, this may mean the software designer encounters difficulties in getting sufficient or appropriate advice from land administration agencies, particularly where there is limited understanding of or prior use of similar IT systems. To overcome these inconsistencies, the software designer makes assumptions of what was "really meant" and it is only at a later stage, possibly even user testing, that any misunderstandings become apparent.

Recognizing the inherent weaknesses in the Waterfall methodology, "Agile" methodologies have evolved to be less rigid, more adaptable, and more facilitative of better understandings between users and system designers, as well as recognition of systemic changes such as business process reengineering. Agile methodologies typically involve continual user engagement, iterative and relatively short (e.g. 3 weeks) incremental cycles of design and development with system functionality delivered progressively. There are many different forms of agile software development including:

- Scrum
- Extreme Programming
- Agile Modelling
- Lean Software Development
- Disciplined Agile Delivery.

The differences between these and other agile methodologies are quite subtle to the non-developer. The choice of methodology will depend on the familiarity and training in a particular methodology within the software design and development team. The lead developer who champions a particular agile methodology should be able to provide previous reference software development projects, particularly those with on-time delivery of a software application. Ideally, the champion would also be able to highlight how flexibility was demonstrated in the development, and a progressive delivery of software functionality throughout the project.

A consequence of adopting an agile methodology is that because the “product backlog” of requirements is added to and re-prioritized throughout development, there is no “fixed” list of requirements. Procurement approaches used by development partners need to be drafted in a way that accounts for agile methodologies and makes clear the performance or functionality goal, in the absence of a list of "fixed" requirements.

Agile methodology is also better aligned to more modern software architectures such as Microservices where the focus is on delivering smaller units of functionality (modularization) rather than a larger complete software component.

4.3.3 What are the components of a Land IT System?

All Land IT Systems are made up of a series of components (building blocks). Together, the components combine:

1. to perform alphanumeric information functions,
2. to perform spatial information functions,
3. to store and manage the recorded data and
4. to enable report generation, to present data in human readable form.

The different options for software development presented in this section speak to the variety of ways these components are deployed. For example, in COTS systems, users are purchasing a ready-to-deploy system where all the components have been selected, combined, and integrated into a fully functioning system ready for deployment. In the bespoke approach, building blocks are selected and integrated from scratch. Just as the open source land administration software utilizes other (open source) software to provide a complete Land IT System solution, so too, the commercial land administration software has a similar dependence on other software components to provide a complete Land IT System. Knowledge of what components makes up a Land IT System solution is important as individual components may require separate software licensing and software update and support arrangements.

Although a Land IT System may support a range of land administration functions (e.g. land registration, cadastre maintenance, property valuation, state land management etc.) underpinning the land administration specific software modules will be various generic software components that can include:

- **Database Management System** (DBMS) to store and provide for efficient retrieval of data (e.g. Oracle, Microsoft SQL Server, Informix, PostgreSQL etc.).
- **Spatial Functionality** to capture, retrieve, display and (sometimes) store spatial land information. Companies providing various products that can be utilized within a land IT solution include ESRI, Autodesk, MapInfo, Bentley Systems, and many others.
- **Digital Archive (Record Management)** to store, index and retrieve scanned images
- **Case Management** to assign transactions to specific staff, record staff actions and approve/reject/send back for correction
- **Report Generator** to extract data from a database or XML file and present it in a human readable form. Often a report generator will come as part of a DBMS bundle (such as Oracle Reports Builder) but there are also options such as JasperSoft that can extract data from several DBMS and generate reports within land administration software.

The tighter these components are integrated into the land administration software the more efficiently the Land IT System will operate and the more powerful the potential functionality. For instance, to view land information in a map view requires less integration than to spatially analyze land information. The downside of greater integration (as with open source software) is that there is

a need to continually monitor change impacts, particularly on building block components, and provide users with software updates to ensure integration continues to work.

There are also procurement implications in that all software, including building block components, must form part of the procurement and be factored into the budgeting of ongoing costs of operation. Another implication is that there is a need to confirm the level of in-country user support for components

4.3.4 Options for software development

Software development can be thought of as encompassing the design of the system architecture sub-components, as shown in the diagrams in Table 2. Although many open source and "Commercial Off the Shelf" (COTS) applications for land administration systems have certain software features that can be configured, a dedicated software development effort is required for most (but not all) new systems to either customize an existing software application or to build a completely new application so it will meet the unique set of requirements necessitated by each context.

This software development effort can take different forms as illustrated in Table 3. There is no single preferred approach, as each approach has its own advantages and disadvantages. The choice of approach should be made based on decisions arising from the preparatory work (identified at the beginning of this Section 4.2).

Table 3: Software development options

Approach	Advantages/Disadvantages	Relevancy
In-house development (by agency staff)	+ Designed to specific client requirements that can be refined throughout development. + Easier to adopt Agile methodology. + Results in in-house software support capacity. + Flexibility to utilize available (commercial, open source, community edition or in-house developed) software modules and components. – Land administration agency assumes direct responsibility – and risk – for the software development. – Requires sufficient in-house expertise to be retained.	Contexts where it is feasible to recruit local software developers as land agency staff. This includes both staff with oversight and project management responsibilities, as well as software developers. Typically involves Traditional Monolith and SOA software architectures but can include Microservices architecture where there are designers and developers with appropriate experience (e.g. New Zealand).

Approach	Advantages/Disadvantages	Relevancy
Bespoke development (by external providers)	+ Designed to specific client requirements + Flexibility to utilize available. (commercial, open source, community edition or in-house developed) software modules and components. + Less responsibility pressure on land administration agency. + Can better enable innovation. - Can be higher cost (but risks may be easier to manage). - Appropriate planning for future system maintenance and future upgrades is essential. - Still requires internal agency oversight (and skills to do so) to ensure software quality and timely delivery. - Software support expenses may be high and need to be budgeted for.	Appropriate where an agency has insufficient internal capacity to develop software in-house. Land agency's project manager should ensure client requirements are clearly understood and agreed with service provider and are based on thorough analysis. Service provider should have had some experience in the proposed software architecture as well as in developing land administration related software. Typically involves Traditional Monolith and SOA software architectures but can include Microservices architecture where there are designers and developers with appropriate experience.
Commercial-off-the-Shelf (COTS)	+ Very short time to implement. + Typically includes some external support and software updates/upgrades for a limited time. – Likely requires alignment of existing business processes to the software (previous approaches require software alignment to business processes). This may require legal reform. - Software licensing and support fees (but these may be comparable to software update and support expenses for a bespoke system).	Most appropriate where there is a complete match between the stated requirements and the functionality of the COTS software has been identified. Requirements need also to be stable and/or aligned to COTS planned upgrades. Software provider can provide guidance aligning business processes to software functionality. Typically involves SOA software architecture.

Approach	Advantages/Disadvantages	Relevancy
Configuration[31] of an available (COTS or OS) software package Adjustment of existing software settings (with no new version of software resulting).	+ Typically undertaken in-house by a system administrator (possibly with support from the software vendor), with the advantage that there is no need to set up a development environment and recompile software. + Time to deliver computerized solution is faster than customization or Bespoke (hours rather than days or weeks). + Code base is consistent between all users and updates/upgrades are easier to apply. - Software license fee (for COTS packages) and support fees/expenses.	Most appropriate where there is a 95% or better match between the stated requirements and the functionality of the generically configured software. The software package must be configurable. The system documentation must include adequate instructions on how to configure the software. Typically involves SOA software architectures.
Software (COTS or OS) customization[32] of existing software package Results in a new, distinct version of the existing software package. Customization may be done in-house or outsourced.	+ Designed to specific client requirements. + Time to deliver computerized solution is considerably shorter than bespoke. + Customization effort can be used to train software developers, if required (either internal to the agency, or external). + Future updates and upgrades to original (un-customized) software package can be incorporated into the customized version in the future. - Software license fees (for COTS packages) and support fees/expenses.	Most appropriate where there is an 80% or better match between the stated requirements and the functionality of the core un-customized software. Existing software package must be customizable. Will require software developers with experience in the software to be customized. Typically involves SOA software architectures.

[31] **Configuration** is where the behavior of a software package is modified by changing system settings so that the package better reflects the requirements of a particular implementation of the software.

[32] **Customization** is where the code of a software package is modified by a software developer to change the original behavior of the package to better reflect the requirements of a particular implementation of the software. Such changes require a new "build" (compilation) using the package's software development kit (SDK) and results in a new distinct version of the software package.

Approach	Advantages/Disadvantages	Relevancy
Land Administration as a Service (LAaaS) Service is provided by an external service provider and any configuration or customization is undertaken by the service provider	+ Matches specific client requirements. + Very short time to implement (compared to Bespoke). + Would require 3-6 months of intensive support for the installation and the use of the service and the (new) associated business processes. – Service fees. – Future service enhancements can be picked up but may require contract revision and fee changes.	Most appropriate where there is: • a complete match between requirements and LAaaS • reliable, affordable Internet connectivity at all service locations • stable or aligned requirements (to LAaaS upgrades) • Limited technical capacity in-house within agencies to oversee software system O&M. May be possible to implement LAaaS on a partial basis (i.e. meeting 75% of transactions) but there are no known cases of this, and it would be recommended as an interim solution only. Service provider can provide guidance on the implementation of business processes aligned to LAaaS functionality. Typically involves Microservices and/or Serverless software architectures.

4.3.5 Open-source Land IT System software

In the last 10 years, the range of software packages supporting land administration functions through Land IT Systems has widened to include open source software packages.[33] These open source software packages are valid options in many of the approaches identified in Table 3. As part of any agency's preparatory research (described in section 4.2 introduction), requirements (functional and non-functional) need to be identified along with other organizational and office environmental factors that are likely to impact on the establishment and operation of the new Land IT System.

Table 4 identifies the advantages and disadvantages of open source software providing Land IT System solutions as well as the factors that need to be addressed. Some of these factors also apply to COTS software, so similarly the identified requirements (functional and non-functional) need to be satisfied regardless of how the software is sourced.

[33] May also be referred to as Free and Open Source Software, FOSS, or Free/Libre/Open Source Software, FLOSS.

Table 4: Advantages and disadvantages of open source software

Advantages	Disadvantages	Relevancy
+ Intellectual property associated with use of the software comes at no cost. + Software source code is always available to access and use and, if necessary, to modify to suit local requirements. + Open source software is usually designed to facilitate software customization to meet local requirements including language localization. + Lower upfront cost.	– An active software community supporting the software is necessary to provide support and updates to meet new security and other requirements. Not all software has this active community, which can result in infrequent software updates and upgrades, reducing the lifespan of implementations and/or increasing cost of support. – Development partner support for open source software is usually project-based, meaning that new software functionality is based on the specific requirements of a country and project (except Global Land Tools Network (GLTN) support for the Social Tenure Domain Model (STDM) software). This can increase implementation costs for new applications, as extensive customization may be required. – Software support costs can be high, especially without an active community. These can be minimized if in-house developers can be trained (and retained) as part of establishing the Land IT System. – An analysis of Total Cost of Ownership is essential to ensure that long-term cost is calculated and budgeted for.	• Where there is some local software development capacity available for future first level software support that is affordable for the land agency (to recruit or to engage as a contractor when required). • Where government policies allow the use of open source software. • Implementations with less than 200,000 properties/parcels/titles (primarily because there is no known experience of open source solutions for Land IT Systems being operated for larger numbers of properties).

Three notable open-source software solutions have been developed for Land IT Systems: Mobile Application for Secure Tenure (MAST), SOLA Registry, and Social Tenure Domain Model (STDM). The applicability of a system again depends very much on the context in which they are being applied, although some general comments can be made as identified in Table 5.

Currently, the greatest interest in these open-source software solutions is from the development partner community, in support of systematic registration or initial community recording and mapping of tenure rights. Typically, open-source software solutions have not been used for systems supporting the management of land transactions (with the exclusion of some SOLA examples). This class of open-source software is typically configured (rather than customizing the software) and is implemented to serve a single community.

Table 5: Description and applicability of open-source software solutions for Land IT Systems.

<table>
<tr><th>Name</th><th colspan="2">Description</th></tr>
<tr><td>MAST[34]</td><td colspan="2">• Developed by USAID and implemented in several countries including Tanzania
• Primarily designed for initial recording of land but does include limited support for a small range of subsequent registrations
• Microservices software architecture with mobile application for field data capture
• MAST Data Management Platform API is Open Geospatial Consortium (OGC) compliant and extends Geoserver API to facilitate interoperability
• Web application
• Takes advantage of FOSS software plugins for QGIS for offline editing of spatial data
• Current installation process requires MAST software developer inputs
• LADM-compliant database</td></tr>
<tr><td></td><td>Where does this solution work well?</td><td>What makes this solution applicable?</td></tr>
<tr><td></td><td>• Systematic registration / initial inventory data capture
• Interim subsequent registration system (until full land transaction system is available)</td><td>• USAID linked project or context
• MAST application exactly matches requirements
• MAST-experienced software developer essential for any new implementation</td></tr>
<tr><td>SOLA Registry[35]</td><td colspan="2">• Supports a comprehensive range of both land registry and cadastre transactions and the archiving and retrieval of associated records
• SOA client-server enterprise software architecture (desktop client)
• Typically installed on office local area network (LAN) but can work with cloud-based server
• SOLA Registry was the initial software package in the SOLA suite of software applications supporting other land administration functions
• LADM compliant database
• Developed to facilitate customization</td></tr>
<tr><td></td><td>Where does this solution work well?</td><td>What makes this solution applicable?</td></tr>
<tr><td></td><td>• Jurisdictions with less than 200,000 parcels/land certificates[36]
• Integrated land registry and cadastre (or co-located land registry and cadastre agencies)
• Minor to medium customization required
• Language localization is required (for new language or where country is bi-lingual)</td><td>• Local software developers available to customize software, implement and support the customized software in the long-term
• Experienced SOLA software developers available to train local software developers in SOLA customization
• Requirements well described and relatively stable</td></tr>
<tr><td>STDM[37]</td><td colspan="2">• Primarily designed for initial recording of land but edit functions can reflect changes arising from subsequent transactions
• Desktop application as a QGIS plugin with shared database on same LAN
• Geographic Information System (GIS) expertise required
• Mobile integration via Geo Open Developer Kit (GeoODK)
• STDM (a LADM specialization) compliant database</td></tr>
</table>

[34] https://www.land-links.org/tool-resource/mast-technology

[35] https://github.com/SOLA-FAO for source code, installation files and documentation

[36] Most implementations have involved less than 100,000 parcels.

[37] https://stdm.gltn.net/features

Name	Description	
STDM	**Where does this solution work well?**	**What makes this solution applicable?**
	• Systematic registration / initial inventory data capture	• Relatively simple application needed • Personnel have some basic GIS skills • Strong community support and/or participatory approach adopted

The only open-source software that is specifically designed to support a comprehensive range of land information and support for (formal, non-customary) land administration transaction processing is the SOLA Registry and the SOLA State Land software packages developed by UN FAO. Although originally designed to be hosted within a provincial or district level land administration agency office with a local server and the office LAN, both SOLA applications have also been implemented on a cloud server with user access by way of the Internet. There is also a non-Internet SOLA "consolidation" utility which allows data captured at one level to be transferred to a sub-national SOLA system and integrated through the manual transfer of consolidation files.

Challenges related to open-source solutions

The most significant concern with the SOLA open source software is that FAO has reduced its support for this software and there is only a very small number of active members of the SOLA software developer community. This has meant that there have only been a few updates to the SOLA source code repositories in the last year. On the other hand, FAO will be making available updated technical documentation on the SOLA software in the coming months. The limited number of SOLA software contributors adding new software functionality to the SOLA software is concerning given the need to replace current desktop client software with web-based software reflecting current trends in client-server software.

Development partner community support for both MAST and SOLA is currently very project driven. This raises uncertainty over the future of updates and upgrades outside such projects. STDM appears to be more proactively supported by the Global Land Tool Network (GLTN) and is implemented in several countries primarily to map and record land in informal settlements and customary areas. STDM strengths lie in the initial inventory of land and it is not well-suited to supporting land transactions.

Software updates are an important aspect to consider, particularly with open-source products, due to the bundle of open-source software components making up a system. To illustrate, most land administration open-source software packages use the PostgreSQL database management system and many function as plug-ins to the QGIS open source GIS. In addition, there are open-source or community edition versions of application servers (e.g. Payara Server), report generators (e.g. JasperReports), GIS publishing platforms (e.g. Geoserver), etc. All these components have active software developer communities resulting in regular updates. So, in such a dynamic open source software mix, the potential of a misalignment between the contributing software components arising with the land administration open-source software is high because there is not an active community monitoring and responding to these changes in these software components.

As with all forms of Land IT System software, with open source software solutions it is important to identify and, if necessary, develop the means of providing adequate software support in the post-implementation and post-project phases when donor support will not be available. Such measures include:

- Recruiting suitably qualified staff into the land agency and training them in the Land IT System software and how to support it.
- Training staff from companies providing software support services in the Land IT System software and how to support it.

- Implementing software and appropriate Internet connectivity on the new Land IT System that allows for remote support.
- Encouraging development assistance partners with open source software to make a commitment to long-term support (i.e. 5 years or more) to their open source software by strengthening the associated software developer community and by providing a software support infrastructure that includes a software update service. This software update service should provide fixes to critical software faults that are identified, security fixes and changes to ensure ongoing compatibility between all software components making up the open source software.

4.3.6 Commercial off the Shelf Land IT System Solutions

The marketplace for COTS Land IT System software packages is dynamic and the scope of this study does not allow for a comprehensive evaluation of all known packages. However, of the proprietary software offerings, there are a number that are notable because they appear to provide "land information and transaction system" solutions for land administration services and have been implemented in a non-pilot, jurisdiction-wide context. Some examples of such packages are ArcGIS Pro Parcel Fabric, Innola Platform and Landfolio, among others. These packages are modern web and cloud-based solutions and hence rely on internet or intranet connectivity.

4.3.7 Hybrid (open-source and commercial) Land IT System software solutions

As modern Land IT System software typically consists of several components, an increasing number of solution providers are utilizing a software "stack" that consists of open-source, COTS, and bespoke components. In this way they are able to design and develop a system that minimizes the software development effort and time to complete as well as providing a solution that better fits both the organization's IT infrastructure and the software development and support skills available within the country. This has been facilitated by commercial and open-source software developers committing to industry standards that facilitate interoperability.

There are obvious cost savings in a hybrid software solution approach that encourages the use of local (and sometimes in-house) software developers, the use of open-source components, and the re-use of existing IT investments.

4.3.8 Considerations for interoperability

In the context of land administration agencies and a country's civil service, the concept of a "whole of government" viewpoint has been promoted as a way to avoid costly duplication, and encourage greater openness and cooperation amongst government agencies and their dealings with citizens. National e-government and NSDI are two of several programs that commonly result from a whole of government perspective. As far as government IT systems are concerned a whole of government approach implies interoperability – the exchanges between systems and software applications used within different government agencies. The adoption of standards is a key means of facilitating interoperability and in particular "open standards" (i.e. standards that can be used royalty free).

In the last 20 years, there has been a greater emphasis on "interoperability" and the adoption of "open standards" and a move away from "compatibility" where certain system and software vendors attempted to dominate by forcing other vendors to adapt their product to facilitate interactions with the more established products. The development (and maintenance) of open standards relies on a very consultative approach and the involvement of an inclusive group of technical experts.

The scope of the open standards that are relevant to the design of Land IT Systems is very wide and is likely to expand as new technologies emerge.

In LIC/LMIC the government systems that may need to be interoperable, or ideally would eventually be inter-operable are:

- National Citizen ID system (Personal ID)

- Revenue Office and/or Stamp Duty Office system (Transaction ID, Personal ID, Company ID, Property ID)
- Taxation Office system (Property ID, Personal ID, Company ID)
- Local Government system (Property ID, Personal ID, Company ID)
- Valuation system (Property ID and Parcel ID)
- State Lease Rental system (Property ID, Personal ID)
- Company Register system (Property ID, Company ID)
- Property Address system (Property ID)
- Utility customer system (Property ID, Personal ID)
- Law enforcement (including money laundering detection) (Property ID, Personal ID, Company ID, Transaction ID)
- Overseas Ownership Register (Property ID, Resident ID, Company ID).

From a government perspective, greater interoperability between the listed systems would result in efficiency and effectiveness gains across a wide range of public sector functions. There are also potential savings to be made through the reduction in duplicated effort and the cumbersome procedures that may exist to attempt to keep some of these linkages up-to-date. Citizens can also benefit directly when systems are interoperable, as it would be easier to establish "One Stop Shop" service centers where a number of government services can be accessed at one location and, ultimately, this interoperability would facilitate online delivery of some government services.

However, it cannot be assumed that there is a widespread appreciation of the benefits of interoperability in all countries including the LIC/LMIC where the challenges are compounded. This is because there can be multiple discrete database and systems with multiple components within any of the many public agencies that could potentially exchange data. Apart from these technical challenges to implementing interoperability there may also be organizational challenges as inter-agency cooperation may not be the norm.

The following table identifies several file formats, protocols, and programming languages that could be considered for adoption as standards within the development of a Land IT system in the interests of facilitating current and future interoperability.

Table 6: Some of the standards of relevance to Land IT System interoperability

Standard Name	Reference	Lead Organization	Description
LADM - Land Administration Domain Model	ISO 19152:2012	FIG ISO/TC211	Facilitates the development and refinement of efficient and effective land administration systems, and enables parties from different countries to communicate, based on a shared vocabulary
Simple Feature Access Part 2 SQL Options	ISO 19125:2004	OGC	Specifies a common storage and access model for most 2-dimensional geometries used by GIS and Land IT System spatial database
GML – Geography Markup Language	ISO 19136:2007	OGC ISO/TC211	Serves as a modelling language for geographic systems as well as an open interchange format for geographic transactions on the Internet

Standard Name	Reference	Lead Organization	Description
PDF/A – a data format for digital preservation	ISO 19005	PDF Association ISO	A "profile" for electronic documents that ensures the documents can be reproduced exactly the same way using various software in years to come
UML – Unified Modelling Language	ISO 19501:2005	Object Management Group	Provides a standard way to visualize the design of a system
BPMN – Business Process Model & Notation	ISO/IEC 19510:2013	Object Management Group	Provides a standard graphical representation for specifying business processes
Java programming language	1998 ->	Oracle & Open JDK community	A general-purpose programming language that is class-based, object-oriented and designed to facilitate cross-platform implementations
Unicode	1988	Unicode Consortium	Facilitates consistent encoding, representation and handling of text expressed in most of the world's writing systems
JSON	ISO/IEC 21778:2017	ISO/IEC JTC 1/SC22	A language independent file format and data interchange format that uses human readable text to store and transmit data objects. Used in data transfers from mobile devices to servers and computers
HTTPS communication protocol	RFC 2818 (2000)	The Internet Society (Network Working Group)	Is used for secured communications over a computer network including the Internet

4.3.9 Procurement options for software solutions

In considering software solution options (including LAaaS and PPP) and in defining a preferred option for a Land IT System software solution it is important to consider the procurement process that will apply in a development partner-supported project to deliver a Land IT System solution. Each procurement process has associated risks to the on-time, on-budget, delivery that meets the technical specification as well as how sustainable the operation of the Land IT System will be post implementation. MCC and all development partners each have specific procurement approaches and regulations that are adhered to. These are not described here.

The most immediate concerns are usually the degree of uncertainty that a complying bid will be received that meets the technical requirements and that the bid price is within the estimated budget, and secondly how likely it is that a bidder can be selected, start work, and execute contract requirements within the project's timeline. Other risks then apply for during and after the procurement. All these risks need to be considered at the time the form of procurement is being decided (the procurement plan).

Each procurement (or recruitment) process is constrained by rules, including how requests for proposals (or applications) should be prepared, products and services described, the proposals (or applications) prepared in response, decisions made on the winning proposal (or application), and, should any bidder feel the process and decision making has not been properly conducted, how appeals can be made and dealt with. The procurement regime impacts both the description of the proposed software solution (by way of standardized procurement documents) and prescribed requirements (by way of the Terms of Reference (TOR)/Statement of Work).

For these reasons, care must be taken in choosing a procurement (or recruitment) option most likely to deliver the software solution that meets the performance requirements on time, or, if there is only one available process, to make sure that the process is carefully managed and that there is an awareness of the associated risks including delays. To illustrate this point, it is not uncommon in the broader land sector community of practice for Land IT System software procurements to be significantly delayed by appeals or re-advertisement for proposals and to then be cancelled because of some other alleged failure in the process.

Attention should also be given to how all associated procurements (or recruitments) will be undertaken because they may impact on the delivery and sustainability of the Land IT System software. Although it may simplify the procurement effort in a project to bundle hardware, LAN cabling, workstation, server, printer, scanners, and other hardware all into one procurement, there are circumstances in which this is not advised. For instance, the lead company (typically the IT services company) is not usually involved in hardware support, does not necessarily have a presence in all land office locations, and hardware consumables (e.g. for printers and plotters) might not be available locally in all locations.

As identified earlier (Section 4.3.2), the ability to use an Agile software development methodology can be constrained by the procurement process. These constraints can be alleviated somewhat if care is taken to describe the functional and non-functional requirements and not how these requirements should be developed. However, a procurement process challenge remains of how to incorporate a dynamic list of requirements ("product backlog") where potentially the priority of individual requirements might change and the specification of acceptance criteria for each completed requirement is part of the consultation that takes place with every (2-3 week) iteration of development work.

A specific concern with the Land IT System software solution request for proposals in LIC/LMIC is the difficulty for local IT service providers to lead a proposal because of eligibility criteria requiring an unrealistically high annual turnover and prior experience in complex Land IT System software solution deployments. From a sustainability perspective, it is highly desirable that local Land IT System expert capacity is available and/or supported to ultimately assist with ongoing software maintenance, upgrades, and extensions. This is more likely to lead to a long-term relationship with the land administration agency and also that the proposed solution will maximize the use of local software development expertise (including software development methodologies and familiarity with local IT infrastructure and hardware suppliers). However, this approach does not preclude there being international partners involved, including in a facilitating role to provide specific Land IT System expertise including upskilling local software developers. Exact arrangements will be unique to a given donor's procurement rules, and the country context and requirements of a given project.

The procurement process and the preparation of technical specifications and TOR represent an excellent opportunity to involve land administration agency staff. Unlike external consultants who are typically used in this role, they have in-depth insights into how the land administration agency and public sector currently works, and they also have knowledge of potential local providers that needs to be incorporated into the technical specifications and TOR. The land administration agency staff involved in the preparation of the TOR have an important role in prioritizing technical requirements as they know the relevant laws and regulation and the business goals of their agency. To facilitate their involvement, it may be necessary to prepare the technical specifications in the local language and translate into a language used by the development partner at the time of technical review. In prioritizing technical requirements, the land agency staff may also need to make decisions on the scope of this implementation of the Land IT System and to defer some functional requirements to a later stage of implementation. The involvement of the land agency staff in these decisions is fundamental as it is "their" new Land IT System that is being described and defined, so a sense of ownership needs to be encouraged, right from the start.

4.3.10 Implementation complexity

Software development implementation complexity has a major negative impact on the technical and financial sustainability of Land IT Systems, likely to be exacerbated by typical LIC/LMIC contexts, such as the lack of in-country capacity to develop, customize or support Land IT Systems involving complex software implementations. The degree of impact varies according to the different modes of implementation and software architectures adopted but impacts of excessive complexity can include:

- the time required to develop and implement the software,
- the cost of the software development,
- unsatisfactory software quality (including, robustness, usability, and maintainability),
- long-term dependency on international expertise to maintain the software,
- greater investment in capacity building,
- greater effort required to migrate legacy system data into the new system,
- difficulty in obtaining and maintaining the political will to proceed with the Land IT System implementation.

Ideally, approaches should be adopted to limit complexity wherever possible. Table 7 identifies factors that provide a preliminary basis for determining likely implementation complexity.

Table 7: Factors that determine implementation complexity

Initial software scope	How 'big' is the software development project? (Is there an existing basis, which land administration functions (and institutional users) are included, etc.?)
Upgrade likelihood	Is significant new functionality or upgrade likely to be necessary in the first 5 years of operation?
System Integration	How compatible are the different components/systems to the solution's software architecture?
Legal framework reform	Does the current legal framework significantly constrain business processes and operations? How likely is legal framework reform during or following software development? Does the legal framework recognize the digital record?
Pre-development business process re-engineering (BPR)	Has a BPR process already been undertaken (possibly using Business Process Model and Notation, BPMN)? How complex are the proposed processes to keep Land IT System records up-to-date? Can the records be kept up-to-date through data from the processing of land administration transactions? How much flexibility has been built into the initially redesigned processes to cater for further refinements later in the implementation?
LADM compliance	Is the Land IT System database structure LADM compliant? How difficult will it be to migrate data from existing digital systems into the new Land IT System database?
Solution maturity	How mature are the new software features, methodologies, and associated technologies (for instance, is the solution attempting to implement a 3D cadastre in a country where there is not yet a consistent and stable digital 2D cadastre)?

Available and affordable expertise	Are there software developers available with the necessary expertise to be involved in the initial software implementation? Are these software developers available to maintain the more complex features of the software beyond the initial implementation? Are there sufficient financial resources to fund development and maintenance? Is there a strong local labor market for IT professionals to join development/roll-out teams? What are the cost implications of future skill dependencies likely to result from the adopted software development approach?

4.3.11 Key considerations for software development

The dilemma of identifying what is the "best system" to support land administration processes in the context of low-income and/or technology-challenged countries has been compounded by:

- A lack of ongoing investment in many software solutions.[38]
- A risk of overemphasis (and possible over-investment) on "hype" technologies – including blockchain as one example.
- Insufficient attention to complexity and requirements for basic maintenance.
- Insufficient attention to business process re-engineering (BPR), including insufficient political buy-in from land agency and related agency heads.

In short, there is no "best system" because the system is less important than getting the basics right, including simplifying and improving processes and capacity building (of key professionals – lawyers, surveyors, notaries – as well as government staff and users). New Zealand and Turkey are two key examples of in-house Land IT System development that have undertaken substantial BPR alongside software development and achieved significant accolades in doing so.

Ultimately, the success of the new Land IT System projects is not just dependent on the identification of the most appropriate solution but also the strong commitment of both the land administration agency and the solution providers.

In this less than perfect situation, it does mean that a forward-looking design to provide support to computerized Land IT System processes within land administration agencies should have a wider view than just software design and include:

- A review of the legal framework with recommendations on how it could be improved to facilitate computerization and minimize associated risks.
- A review of the public sector policy framework on how the land administration processes fit within that framework and the identification of any public good services, as well as the appropriate type of public sector (or private sector) arrangement to deliver those services.
- A review of other public sector technology related initiatives such as an e-government program and NSDI program to identify any desirable linkages.
- BPR of the land administration processes targeted for computerization before software design begins.

[38] This applies both to open source software and to COTS, where arguably both have suffered from an unsettled marketplace, the undermining of (perceived) competitor's efforts and difficulties in establishing and maintaining business models that ensure returns on investment, both financial and otherwise.

- The identification of any organizational infrastructure improvements that need to be initiated to ensure future business continuity of processes supported by this computerization.

The initial software design should take these findings into consideration. Finally, once the software design is completed the preferred options should be subject to risk analysis covering both the implementation and operational risks. Ideally any risks should be quantified and treated as costs in a Total Cost of Ownership calculation accompanying the request for approval to proceed with the computerization.

The following identifies some guiding questions to inform the choice of appropriate software architecture, development methodology and approach.

Table 8: Key considerations for software development

Policy/Legal	• Are there any laws or policy directives for the system server and database hardware to be physically located in this country? (i.e. Are there any legal or policy constraints to a cloud-based solution?) • Can any mismatch with the essential requirements be remedied by customizing the software or Land Administration functions "as a Service" or is there a requirement to amend the policy/legal framework in order to relax the essential requirements? What are the consequences of these compromises?
Technical	• Will the implementation of the new land administration services be a single centralized system or a series of autonomous, decentralized, sub-national systems? • Are there any new local initiatives (e.g. e-government, NSDI etc.) that need to be aligned with the new land administration software/system or services? • How good is the match between the essential requirements that have been identified and the off-the-shelf functionality and specification of proprietary or open source software or commercial Software as a Service (SaaS)? • What is the state of the local IT market? Are there software developers with the right skills, who are available and affordable to support the software development or software customization effort, and continue with ongoing maintenance? • Are there any new land administration system features from other countries (e.g. blockchain, 3D cadastre, digital lodgment, biometrics, Optical Character Recognition (OCR), etc.) that need to be incorporated in the initial implementation of the land administration services (or potentially included in future upgrades)? Why are these system features from other countries important to this country?
Risk	• What are the significant risks to the performance and integrity of the current means of providing the land administration services? How are those risks affected and new risks introduced with the options being considered? • Is a solution involving a series of autonomous, decentralized, sub-national systems viable?
Cost	• Where do the new land administration services need to be available? What is the cost of providing robust Internet connectivity to all these locations? • Is the current budget for land administration services enough to cover the operation of new computerized delivery of land administration services? • What is the expected source for the necessary capital and operational expenditure and the constraints associated with that source? • How will the implementation of the new land administration services be financed?

Responses to these questions allow implementation options to be identified, cost estimates prepared, risk assessments made, and recommendations on the most suitable implementation option to be documented and included in the software architecture description.

4.4 Accessing land administration as a service

In recent years, a new strategic approach for the computerization of land administration services has evolved, accessing computerized Land IT Systems "as a service".[39] The development of this approach is being driven by technology, particularly the development of micro-service architectures, cloud-computing, and improved telecommunications networks.

The concept of accessing land administration "as a service" is attractive to development partners and funders as it substantially increases the likelihood of sustained system performance over the life of the service agreement and avoids the usual, often repeated pitfall of government agencies being unable to muster the know-how or resources or both to address system issues, which can spiral into system dis-use or abandonment. The "as a service" model is also attractive to governments, particularly those that do not want the extra burden of maintaining infrastructure and associated overheads. An "as a service" model could be used to establish a predictable, fixed annual budget for the government that covers the fee for the service. This approach could include more than just the software, but also the data, training, systems, etc.

The new technology has widened options but is meeting resistance from land sector agencies. Land administration agencies typically have a range of concerns on issues such as data security and integrity, privacy, data pricing and general control over the access to data and hence retain the ability to respond to new government initiatives. This means that land administration agencies typically favor the development of on-site Land IT Systems. The business processes and business logic for a Land IT System is very specific to the legal/regulatory environment and this can be a barrier to the adoption of an "as a service" model. These concerns can and have been addressed. Land agencies in several countries have demonstrated that cloud-based systems can be implemented while maintaining core policies on data and system security, privacy, and data access. Amending the legal/policy environment and/or configuring/customizing Land IT System software are clear strategies that reduce the technical barriers to adopting Land IT Systems as a service.

Systems have evolved to the stage where accessing computerized Land IT Systems as a service is a viable option. These options include:

- a global, web-based technical platform with access to spatial data sets that facilitates the documentation of property rights. The model used is simple and easy to implement but perhaps has limited capability to record subsequent transactions.
- the offer of comprehensive cloud-based software that has been developed for a major government provider of land administration services. This software was developed after significant business process re-engineering, but it is very specific to the jurisdiction.
- The offer of open-source software with a unified database that is scalable and customizable, cloud-ready with blockchain under a pricing structure with a one-time fee and the option of access to the source code.

[39] The term "as a service" refers to something being made available to a customer as a service, typically over the Internet. The term "land administration as a service" is used to describe an arrangement for government to access through an external supplier the Land IT System and perhaps other services that are necessary for the provision of land administration services. This arrangement differs significantly from the traditional approach where the government establishes and maintains a government Land IT System and associated capability.

- a land administration offering based on a platform that has been designed as readily configurable to comply with each country's requirements that is available as a service based on a simple financial offer of a fixed set-up cost and fixed annual fee.

Other options continue to evolve as other government agencies seek to introduce the land IT software as a service approach. However, the success of these offerings will depend a lot on the ability to configure/customize the software and the costs of doing so.

There is also the option of only adopting Land IT Systems as a service to address the most important transaction types. As noted above, although most land administration systems provide for many different types of transactions, in most systems a high proportion of the transactions and revenue from user's fees and charges come from relatively few transaction types (typically transactions related to transfer of ownership and mortgages). This raises the possibility of a government deciding to use LAaaS for the most common and most important transaction types, leaving the other, less frequent transaction types to be picked up by the manual or legacy systems. Adopting this hybrid approach would address the most important transaction types while minimizing any requirements to customize software.

There is little information available on the likely pricing models for the various LAaaS offerings. From a supplier's point of view, there will be a requirement for an initial capital investment and an ongoing operational cost in providing services. Much of the capital investment will be the configuration/customization of the software platform, although there may also be a significant requirement to invest in physical infrastructure such as offices, ICT, and other equipment. If the requirement for configuration/customization is minimized, either by limiting the services offered by the LAaaS or by streamlining/changing existing procedures and processes, then capital investment can be reduced. The ongoing costs of providing a LAaaS will predominately be staff and overhead costs, office, communications and utility costs, office consumables and ICT costs (which are likely to include third party license fees, hardware and software maintenance, and data storage/archiving). For these reasons, the pricing models for LAaaS are likely to be a mixture of an upfront charge, annual subscription fees, and possibly a transaction fee. The pricing models are likely to be very specific to the project being developed or considered.

The prerequisites and challenges in considering accessing a LAaaS are:

- willingness by government to move to an "as a service" model,
- the availability of a software platform that:
    - can fulfil the requirements of the existing legal and regulatory environment,
    - includes flexible work-flow management,
    - can apply different business rules and logic,
    - can demonstrate scalability,
- availability to the LAaaS supplier of experienced experts to undertake the configuration/customization and support the operations,
- a cost model that is acceptable to all stakeholders (government, the supplier, and users). This cost-model may need to be supported by a development partner/financier, ideally with the development partner supporting the up-front investment and the ongoing operation of the LAaaS supported by routine budget allocation and/or retained revenue from user fees and charges.

Where the LAaaS is based on cloud technology there are two further prerequisites:

- willingness by government to accept a cloud-solution that can be structured to address concerns about data security and privacy,
- the ability of the ICT infrastructure in the country to support a cloud-based solution.

The policy requirements, prerequisites in place, and necessary safeguards and the advantages and disadvantages of adoption a land administration 'as a service' model are summarized below in Table 12.

Table 9: Prerequisites and advantages/disadvantages of an 'as a service' model

Policy requirements	Other prerequisites and safeguards	Advantages/disadvantages
• Agreement to move to a services model • Agreement to accept cloud-solution (if applicable)	• Suitable software available • Experienced specialists available to configure/customize and support software • Acceptable cost model • ICT infrastructure supports cloud solution (if applicable) • Service level agreement so there are no surprises or unexpected requirements • "Exit" clause defined at onset • Formal change order process • Strong contract terms drafting, negotiation, and enforcement by government • Data security standards for cloud storage (if necessary) • Formal audit and reporting structure • Ability to escrow funds (if necessary) • Ability to repatriate funds without penalty (as appropriate) • Government/sovereign/sub-sovereign guaranty (in some cases)	+ Access to latest technology + Increased data security + Allows government to focus on functional/non-functional requirements and business processes + Transfers responsibility for software/ hardware refresh to service provider with more adequate software maintenance skills + SaaS arrangement assures resource availability for maintenance/updates – these are built into the service agreement – mitigating a main risk impacting sustainability in LIC/LMIC + SaaS model can also be designed to include other aspects of land administration such as data maintenance/conversion, ICT maintenance, training, public information/awareness, etc. + Time to market with viable operating environment is faster which results in revenues materializing faster - May require changes to legal framework - Requires changes to business processes - Will require configuration/customization from specialists - Requires that issues related to data privacy and security are addressed

4.5 Hardware considerations

The following section provides a brief discussion of key hardware trends that will impact Land IT System investments. In general, good practices are best achieved through clear identification in procurement technical specifications; ensuring hardware compatibility with adopted approaches and objectives; provision by recognized suppliers, with adequate warranty periods as applicable; and procurement undertaken on a lowest-cost tenderer basis.

4.5.1 Semiconductor processing power

Exponential advances in semi-conductor efficiency have been achieved over the past 50 years, alongside significant manufacturing cost reductions (IEEE, 2018), benefitting Land IT Systems implementation and reform. Whilst comparable increases in computer processing power in the future are likely to be harder to achieve, this is unlikely to significantly impact future first-generation Land IT System investment in the short-to-medium term – adequate processing power required to host such systems is now easily afforded within most development assistance funded projects.

This is not to say that further efficiencies will not be achieved and/or will not have some benefits. Three potential trends that have future impact include: cloud computing, future networks (such as 5G), and quantum information processing. However, benefits to LIC/LMIC Land IT Systems are unlikely to be seen in the short-term. Encouragingly, the IEEE predicts the most dramatic processing improvements to occur in the mobile device sector (e.g. resulting from wider bandwidth). This may provide some opportunity for LIC/LMIC to leapfrog traditional connectivity infrastructure and have some positive flow-on impacts to accessibility and data collection processes.

4.5.2 Minimum hardware requirements

A standard set of minimum hardware requirements for the first instance of a computerized Land IT System implementation in a land office (sometimes referred to as the “first-generation” Land IT System) can be useful to provide guidance covering likely operational demands plus some redundancy to cover the eventuality that certain critical hardware items fail.

The hardware requirements for a typical first-generation Land IT System should include:

- A rack server (ideal) although a desktop computer with a high-end specification will suffice in hosting a server application for a small office LAN. If there is an existing server, it might have spare capacity to host the new system. Cloud storage is an emerging trend, but not yet a minimum requirement given Internet connectivity remains problematic in many LIC/LMICs.
- LAN router and cabling in the office for all users requiring access to the system (a wireless router may be an alternative or backup to cabling).
- UPS and batteries (to protect the server for 4 hours at a minimum).
- Air condition unit for the server room.
- Desktop computers with UPS protection (laptop computers are recommended where power supply is unreliable, although security cables for the laptops are essential).
- Panchromatic laser printers at public counters and other places where printed output is required (minimum of 2 printers).
- One A3 Color Inkjet printer (for ad hoc cadastral map outputs).
- A3/A4 scanners with automatic document feed at the public counter (minimum of 2 scanners).
- Tablet mobile devices.
- At least a 6-month supply of printer consumables (paper, printer toners and cartridge and inkjet cartridges etc.).
- A means of “as-required” Internet access for remote support (which could be as simple as ensuring the wi-fi router has a sim card slot).

Obviously, the hardware requirements for a Land IT System will evolve and become much easier to identify with operational experience – for example, server processing power, storage and backup requirements, and the optimal numbers and locations of workstations, printers and scanners will likely

become very apparent. Process reform alongside this operational experience will also contribute to better understandings of current and future hardware needs.

4.5.3 Document imaging

The ability to easily scan and retrieve key historical paper-based records (such as index books, land certificates and maps) as well as paper-based records associated with new transactions is essential functionality for a Land IT System.

While the format and quality of any paper documents required in support of new transactions can be specified so as to facilitate the scanning and incorporation of the scanned images into the Land IT System, that is not the case with existing paper land records and maps.

Ideally, the historical paper land records that are still essential to the processing of land administration transactions also need to be scanned in parallel with the implementation of the new Land IT System. Because these older records are often in poor condition and vary in size, this scanning work is best contracted out, although land administration agency staff will need to be involved in the preparation of these records for scanning. Once scanned, consideration needs to be given to the long-term archival arrangements. Operationally, the scanned images of these records are what the land administration agency needs, once the Land IT System is operational. Some of these old land administration records will have historical value and possibly these should be transferred to the public agency responsible for the management of historical records generally. Others may be transferred to a central purpose-built land records archive facility or alternatively these records should be disposed of (subject to changes to the legal framework to permit official records being destroyed). Paper records archives within local offices of the land agency should be repurposed as part of the modernization of the land administration agency accompanying the implementation of the Land IT System.

Recent trends in imaging include:

- Mobile “friendly” imaging applications.
- Adjustable solutions (involving hardware (such as mounted cameras) and associated software (to crop image, change contrast, color balance and resolution etc.) that scan multiple document formats (A4 and larger).
- Security provisions to guard against inappropriate changes to scanned images.
- TIFF and PDF as the most popular formats used in imaging solutions.
- The promotion of the open/non-proprietary PDF/A data format for digital preservation (ISO 19005 – http://pdfa.org).
- Cloud-based imaging solutions (e.g. www.templafy.com).

These trends highlight that document imaging and digitization is becoming easier and faster and will not of itself remain a significant barrier to Land IT System reform. More problematic is ensuring the image quality of captured documents.

4.5.4 Mobile device technology

In the last 10 years there has been a proliferation of field data capture (including mapping) software applications running on mobile devices (including custom-made devices and regular, general purpose mobile phones and tablets). These systems have primarily been used in mapping exercises including

systematic registration. There are also other mobile software applications to provide access to land information.[40]

In the immediate future it seems likely that the use of software applications for mobile devices will also be used in conjunction with Land IT Systems where they will be used within land administration agencies to:

- scan the supporting (paper based) documents for a transaction,
- retrieve document images stored through the land transaction system,
- verify the identity and authority of a person to lodge a transaction for a land administration process (including registration),
- enable remote digital lodgment of a land administration transaction,
- undertake simple data entry associated with processing a land administration process,
- track the progress of a land administration process.

4.5.5 Spatial technologies

Spatial technologies such as GNSS, total stations, high resolution satellite imagery, orthophotos, laser scanners and digital cameras (or laser scanners) mounted on an unmanned aerial vehicle (UAV) or drone are widely used in mapping and surveying (including mapping supporting systematic registration). As such their use is ubiquitous with the spatial data made available through land information systems. They are also used in support of land administration transactions associated with the approval of changes to the cadastral boundaries resulting from parcel subdivisions, merges, and corrections, and also the acquisition of land for various public works or purposes. The digital lodgment of cadastral datasets (that replace the formal submission of a paper cadastral survey plan to a land office) conforming to a standard format (e.g. LandXML or a standard GML based format) with the land administration agency for verification, approval and incorporation into the Land IT System is a promising trend. Digital lodgment facilitates streamlined processing within both the land administration agency and the surveyor's office, and also permits a significant degree of automated data validation.

Key challenges in implementing new trends in spatial technologies primarily lie with ensuring and maintaining adequate local skills and capacity (across not only implementing agencies but also the supporting private sector and, critically, the public who will be using Land IT System services). Typically, low-cost and low-tech approaches (according to ""fit-for-purpose"" principles) are recommended for countries still needing to achieve first registration.[41] Low-technology approaches can also better enable essential public awareness and participation approaches, which are often overlooked or required as separate activities with automated approaches. Countries looking to upgrade Land IT Systems (that have relatively complete geographic coverage) are those that will benefit from further review of latest innovations in spatial technologies in so far as spatial data quality improvement and further streamlining of land administration agency processes. Some companies (e.g. Leica Geosystems, Trimble) are beginning to offer "Positioning-as-a-Service" to governments as an alternative to government owned and maintained CORS networks, either for national-level permanent use or as required for specific project durations, and these can include hardware updates. These offerings may be considered for supporting infrastructure that underpin Land IT Systems, either as

[40] Examples include the USAID MAST application (https://www.land-links.org/tool-resource/mobile-applications-to-secure-tenure-mast/) and the UN FAO Open Tenure application (http://www.fao.org/tenure/activities/administration/recording-of-rights/software/en/)

[41] These are detailed further in McLaren, et al. (2018)

vendor provided Continually Operating Reference Station (CORS) solutions, or add-on technologies that support improved accuracies and rapid data collection.

4.5.6 Managing hardware through cascade maintenance

The general-purpose nature of the hardware required to host and support relatively simple Land IT System setups, as would be expected to be found in LIC/LMICs, mean that the hardware and equipment procured for these systems is not likely to become obsolete fast and, when it does, it can be "cascaded down" to a less demanding task within the land administration agency. For instance, the server becomes an email server or a training server (for the Land IT System) and a new server with more memory and faster processing speeds is procured through the agency's regular equipment replacement budget.

Planning for maintenance, obsolescence, and hardware upgrades is an essential, but often overlooked, component of Land IT System reform. Typically, most hardware can be expected to last for at least 5 years – but this can vary considerably in less-developed countries. For this reason, it is recommended that with all essential hardware items there is some redundancy allocated to allow for immediate replacement should a hardware item fail.

Another consideration is to make provision for common early upgrades to the Land IT System hardware platform that often become apparent after a period of operation experience. These include:

- more workstations (desktops or laptops) as more land administration processes are supported by the Land IT System,
- more LAN hard disk units,
- more monitor screens (to allow for dual screen setups for workstations).
- devices to facilitate faster Internet access.

4.6 Connectivity options

Connectivity requirements are impacted by how computerized the Land IT System and supporting services will be.

For system setups, a locally based client-server utilizing Monolith or SOA architecture will only require a reliable LAN setup.[42] Cloud-based solutions, though, require a continuous, reliable, medium speed Internet connection and a reliable LAN setup (these solutions include blockchain). Supporting services requiring significant connectivity include web-based imagery and cloud-based database backups. Solutions utilizing web-based imagery for the reference map layer (e.g. Google Earth) will require a continuous, reliable, medium speed Internet connection. A cloud-based database backup (e.g. Dropbox) will require the same, possibly at higher volume. Occasional remote software support and updates will also require reliable, on-demand Internet connectivity.

4.6.1 Local area network

The ideal specification for LAN connectivity is **CAT6 or better cabling plus wireless connectivity** (from the server) to all work areas where critical processes that are supported by the computerized system are performed. The wireless connectivity provides backup connectivity should the LAN cabling be damaged in anyway (e.g. rodents).

[42] Recognizing the need for appropriate processes to share information between geographic office locations.

4.6.2 Internet connectivity

The state of national communication infrastructure has become a legitimate measure of development and future development (Brown and Mickelson, 2018). There are several different ways land agencies presently connect to the Internet:

- Leased Internet line to a specified bandwidth and speed.
- Regular broadband service provided by a telecommunications provider.
- SIM card-based devices connected to the server (typically only feasible to provide occasional remote support).

Delivery of affordable, fast Internet to rural communities remains a critical challenge to all countries, and especially those in Africa. Studies suggest just 20% of people in sub-Saharan Africa use the Internet, whilst the global average lies closer to 50%, although this does not account for cybercafe and Internet kiosk users.[43] Low-income, landlocked countries are particularly affected, located away from high-performance submarine Internet cables.

Despite this, the telecommunications market in Africa is seen as one of the fastest growing in the world. Classic models of multinational telecommunication companies providing Internet infrastructure are the norm, with state-owned service providers in decline. However, there is a strong focus on broadband wireless access technologies, building on the growth of mobile device penetration. Wireless connections typically go through satellite links, which are expensive, and there are concerns that the European dominance of Internet service providers also increases local provider costs, with the absence of clear regulation around inter-Internet Service Provider (ISP) cost partitions.

There are several emerging alternatives, driven in part by technology companies seeking to address government censorship, although these predominantly address the "last mile" problem (relating to the direct link to users, particularly in remote areas) and relate more to user access, rather than reforms or trends that might better enable Land IT System infrastructures. They may, however, aid in public participation and information access, and assist in rapid disaster response. Examples include:

- **Unallocated broadcasting frequencies "White Space (TV)"** where TV high frequencies (470 – 700 MHz) are unused or can accommodate secondary users this frequency range can provide Internet connectivity within 10 km of the TV transmitter tower with the assistance of special receiver devices. This service is dependent on an appropriate provision in the national frequency regulation framework and relies on the service not interfering with existing TV transmission.
- **Google "Project Loon" Balloon** service, which plans to provide an aerial wireless network that is connected to solar-powered ground base stations. However, there remain significant challenges to overcome to achieve viability, including the limited life of the balloons, solar power/battery reliance, etc.
- **Low Earth Orbit (LEO) Satellite** Internet services, which are beginning to be implemented by several companies (Space X "Starlink", One Web, Amazon "Project Kuiper", Telesat and LeoSat). However, this approach requires thousands of satellites per provider to provide comprehensive coverage, raising concerns about the clogging of orbits.

Connectivity barriers remain, including high costs, power availability, and local capacity. These technologies are not viable options in the Land IT System space.

[43] The Asia Pacific region has an estimate closer to 40% of total population. (ITU, 2018).

4.6.3 User access to Internet

Regardless of how Internet connectivity is provided, and particularly if this is the first time that Internet connectivity has been provided within the land administration agency (or the first time for a new group of staff), certain measures will need to be put in place to guard against overuse (intentional or accidental) and inappropriate use. Such measures should include:

- A Protocol of Acceptable Computing Practices for Land Administration Agency staff that includes Internet access and Land IT System use. This should be part of user training and it requires staff to agree to comply with the protocol before they are enrolled as users.
- Blocking of all social media, pornography, and Internet-based email services (email only made available through the agency's corporate email setup).
- Daily monitoring of the volumes of data downloaded (and uploaded) and Internet use.
- Monitoring of the "monitors".

4.7 Ongoing systems operations and maintenance

There are a number of factors that impact on what operations and maintenance functions are undertaken inhouse and others that can be out-sourced:

1. The introduction of a Land IT System is typically used to ensure greater consistency in how land administration services are provided and processed especially at the sub-national level and with users external to the land administration agency. As this is a significant and sensitive element of the organizational change associated with the implementation of a Land IT System, this is usually an in-house responsibility for the land administration agency
2. Land administration agencies retain the responsibility to approve certain land administration transactions and hence need to advise parties to these transactions on matters of appropriate land administration practice (including legal compliance) and not just how to use the Land IT System.
3. Local system administration support is essential
4. User software support will depend on the complexity of the Land IT software and user skill
5. Software updates (and most software upgrades) can typically be delivered to the central office of the land administration agency if there is suitable and affordable internet connectivity

To appropriately deal with these factors, a typical regime of operational support will include:

- a **User Support Center** staffed by in-house "super users" who are available:
    - to answer Land IT System user queries (maybe involving a dial-in user support desk),
    - to improve how users are using the Land IT System, including further training or updates to system user manuals,
    - to identify software enhancements and document software faults.
- **system administration services** in-house or out-sourced.
- **software support** (including updates, upgrades, and fixes to software faults (bugs)) provided by the software vendor (or developer) remotely through web connectivity or through a local agent for the software vendor (or developer)

Promising new developments that can assist operations support are:

- **Simplified installation tools,** especially assisting multiple system component installations and non-Windows platforms, e.g. www.docker.com
- **Issue and Fault Reporting and Tracking systems** e.g. www.lighthouseapp.com

- **Remote Desktop Access** e.g. Windows Remote Desktop Protocol, Team Viewer and VNC Viewer
- **Cloud-based storage** (with synchronization) for offsite storage of database backups.

4.8 Adopting a Total Cost of Ownership (TCO) approach

TCO is an approach to more rigorously identify all the costs associated with the development and operation of a new system over the lifecycle of the system. TCO encompasses the initial cost of system development, ongoing operational and maintenance costs (including any planned or unplanned downtime), and any potential residual value (i.e. at the end of the system's anticipated lifespan, can anything be reused to reduce the cost of the next significant upgrade). As with any form of economic analysis, its value is reliant on how well the input costs are substantiated. TCO has been used extensively in the private sector to evaluate the financial impact of ICT proposals involving new systems and software for the last 30 years, but TCO has seemingly been underutilized in Land IT Systems development generally. An emerging trend in the land sector is to recognize the value in using a TCO calculation to obtain a more objective valuation for any new Land IT System under consideration by a land administration agency.

One reason for this underutilization is perhaps the varying length of Land IT System lifecycles: these have typically been 10 years or longer (before a significant upgrade has become necessary), compared with system lifecycles of 5 years referred to in the TCO literature. Another reason could be the lack of standardization in the TCO calculations. The range of costs that can be included in a TCO assessment for a technology deployment such as a Land IT System are extensive[44] and can include "soft costs" (Sanjak and Grusczynski, 2015) such as replacement cost (system depreciation) and the costs of operational risks. In many situations it would be appropriate to add the cost of any initial paper record-digital data conversion or data migration exercises needed for the operation of the Land IT System. These issues need to be addressed to allow for more widespread usage of the TCO approach in evaluating new systems.

There are alternatives to TCO, including Return on Investment (ROI),[45] Internal Rate of Return (IRR),[46] or payback period.[47] Comparatively, TCO has a longer-term focus, better enabling analyses of full lifecycle costs, not just initial "purchase" price. Some limitations, however, include an inability to take business value into account, (for example, risk, or the cost of *not* implementing reform), limited ability to take account of more dynamic or uncertain data (for example, to better understand longer term costs that might influence decisions), and difficulty in quantifying some decision elements (e.g. flexibility, configurability, etc.). Despite these, TCO provides a good initial basis for comparison between open source, commercial software, or hybrid options, making it a useful approach for future Land IT System investments. Development of a standardized approach, possibly integrated with some elements of IRR or ROI, might assist in ensuring a fair comparison between offerings, and better encompass risk elements and build a business case for implementation.

As an approach for future Land IT System investment, TCO can be applied as a means of:

- Evaluating proposed land administration service solutions (irrespective of the mode of solution).
- Collating costs in determining economic value of a land administration service.

[44] Annex 2 provides a list of technology deployment costs that can be included as part of TCO.

[45] The value of the future benefits in present dollar value.

[46] Which can be thought of as the benefits of a project expressed as an interest rate.

[47] The time it takes for a project to repay the cost of the project.

- Preparing a “Sustainable Business Plan” (GLTN, 2016) where the focus is on identifying the likely costs that will be incurred by the land administration agency, which need to be accommodated from budgets and revenue streams that the agency controls.
- Developing cost recovery models.
- Identifying additional measures to assess risk and opportunity costs, which may be necessary to support initial financing.

5 Strategic decisions for Land IT System reform

Land administration services are provided through many different modalities.[48] Services may be provided by a single agency, or multiple different agencies, sometimes in different ministries. There are also many different modalities for the level of government that provides services. In some countries the cadastral survey is a national responsibility and the registry is a local government responsibility, while in others it is the reverse.

Land administration is typically a public service provided by government. Government establishes and maintains the policy and legal frameworks for land administration and establishes and maintains the government institutions that provide land administration services to both government and the public. Government also establishes the standards for key land administration services, such as the specifications for cadastral surveys, and many land administration services require the formal approval of a government official. Private sector notaries, lawyers and cadastral surveyors, and other intermediaries play a significant role in many land administration systems.

The full funding by government of the expenditure required to provide land administration services is the traditional approach that has been adopted in many countries. In LIC/LMIC the reliance on government budget allocations, which are often unpredictable, can make provision of effective and reliable land administration services difficult or impossible. This presents specific challenges related to IT systems, where predictable resourcing is necessary for the ongoing operations and maintenance required for sustainability. The revenue that governments generate from the provision of land administration services typically goes directly into consolidated government revenue. However, there are lessons and experience from governments using the revenue generated from user fees and charges to finance the provision of land administration services. These arrangements overcome the reliance of annual budget allocation and can ensure that the institutions providing land administration services have the funds available to make any investment in Land IT Systems sustainable.

The land administration systems in LIC/LMIC face a range of difficulties including: highly centralized, under-resourced offices; complex procedures that can be expensive and time consuming; limited resources and training; difficulties and unwillingness in sharing information and data; high fee structures; resistance to change; lack of a critical mass of property registered in the system; and a lack of public awareness/participation. This chapter reviews these and the other factors relating to decisions on land administration reform.

5.1 Focusing on sustainability in decision-making

Many aspects need to be carefully assessed when considering an investment in a Land IT System, or even in the broader scope of investing in land administration reform. These aspects are considered in a holistic manner in the section on design principles and checklists (section 6), but two key strategic questions are worth exploring in some detail. These are:

- What service delivery modes do governments use to provide land administration services?
- How is the ongoing provision of land administration services going to be financed?

The following sections explore these two questions by reviewing:

- The institutional arrangements for delivery of land administration services, which are linked to IT decision-making
- Financing arrangements used to deliver land administration services.

[48] There are many references on land administration systems and service delivery (key references include: Larsson (1991), Dale and McLaughlin (1999) and Williamson, Enemark, Wallace and Rajabifard (2010).

5.2 Delivery of land administration services

Governments at national or sub-national levels typically establish the policy and legal frameworks for the provision of land administration services. The governments at national or subnational levels also have prime responsibility for establishing the institutional arrangements for the delivery of land administration services. These arrangements focus predominantly on national/sub-national government agencies providing land administration services and this is the traditional institutional arrangement that would be reviewed in any assessment and design of a Land IT System.

However, the institutional arrangements also typically include roles and responsibilities for local government, private sector service providers and possibly other institutions. The term "private sector providers" includes the traditional provision of services directly to users by individual private service providers such as private notaries, lawyers, and cadastral surveyors. The term also includes a broader scope of private sector services that really falls into a continuum that can vary at one end from a simple service contract with the firm who built the software to provide periodic maintenance and upgrades within a traditional national government delivery structure and at the other end of the continuum, a highly sophisticated PPP arrangement. Any investment in Land IT Systems needs to consider these other roles in the delivery of land administration services, both the current arrangements and any likely future arrangements. The following sections looks at the involvement of these other institutions in the provision of land administration services:

- local governments,
- private sector service providers,
- civil society or the general public through crowdsourcing.

5.2.1 Delegating responsibility to local government

Delegation in urban or other environments with typically adequate IT capability

Local governments in urban areas and major cities are often primary users of land administration data, particularly the spatial data in the cadastre. This data provides the spatial framework for a range of typical local government roles and responsibilities. These roles and responsibilities vary globally, but may include:

- assessing and collecting property taxes or rates,
- spatial and land use planning and environmental protection,
- development approval and building permits,
- development and maintenance of local roads,
- flood prevention and storm water drainage,
- waste collection and disposal,
- management of public parks and properties (halls, libraries, community centers, etc.),
- establishing and maintaining the street addressing system,
- licensing restaurants and businesses,
- provision of public utilities (water, sewerage, power).

Local government typically develops systems to gather and maintain the information they need to meet their statutory responsibilities and make key decisions. These systems typically are not

interoperable with cadastre/registry systems.[49] Property boundaries are a key data layer that is required both by the land administration system and local government. With this synergy there is some logic that governments might assign responsibility for the cadastre to local government.

In Peru, like many Latin American countries, there are many cadastres including an urban cadastre that is the responsibility of approximately 1,800 municipalities. The standards are set by the Ministry of Housing, which integrates the urban cadastre. However, most municipalities in Peru lack the capacity and resources to develop and maintain their urban cadastres, particularly given the high standards that have been set by the central government and the lack of technical and financial support provided to local government. The World Bank is reportedly preparing an Urban Cadastre Project in Peru to address the funding and capacity problems.

In Peru, the responsibility was assigned to local government in a law in 2004. Standards have been prepared to implement this law, but little technical and financial assistance has been provided to local government to implement the law and standards. With the rapid development of improved positioning systems (with GNSS, CORS and increasing sophistication in mobile devices) and readily available high-resolution satellite imagery, there are less technical concerns about assigning the work to local governments. However there appear to be some clear prerequisites, including:

- Clear standards and guidelines for cadastral surveys and mapping, preferably formulated under a ""fit-for-purpose"" approach that focuses on the needs of key users and citizens rather than imposing state-of-the-art technology and very accurate surveys.
- Financial and technical support to local governments in implementing the standards and guidelines from central land administration authorities.
- Effective local governments with the resources and capacity to undertake the work.
- Some system of quality assurance and control, such as the licensing of surveyors.

Delegation in areas with weak or inadequate IT capability

The most significant recent land tenure reforms in Africa are those that decentralized to local institutions the functions of recognizing and registering rights. This reform brings the provision of secure tenure and land administration services much closer to populations and makes it much more accessible, but the institutional challenges and obstacles of creating and maintaining complex systems of records and transactions in these environments can be significant.

In many rural environments in Africa there are enormous limitations in respect to financial resources, human resources, and electricity and internet supply. Providing support for land information and transaction systems in these environments – which are in fact the ones quite often targeted by MCC and other development partner-funded projects – requires particularly thoughtful decision-making on key aspects such as tools for record-keeping and future transaction management.

In many situations it may be better to invest in improved manual systems to record property rights and transactions in these rights as an interim step in moving to more advanced Land IT Systems as capacity and resources develops. Such a strategy might:

- Develop simple, clear procedures to record and approve rights and transactions, supported by comprehensive guidelines and training material

[49] It is important that a Land IT System is interoperable with other systems supporting associated functions such as personal identification, company registration, property tax assessment/collection, land management, land use planning etc. This is discussed in section 4.3.8.

- Introduce simple map systems to support the land record system, possibly using high-resolution image maps
- Design and deploy low-cost land records management systems, including secure record storage facilities and robust systems to access the information (cross-indices linking map, document, and person records, possibly supported by simple IT applications such as document tables or spreadsheets)
- Design and implement a comprehensive training program
- Undertake comprehensive public awareness and information campaigns to ensure that the population understands the law, procedures, and the benefits of having their rights recorded.

5.2.2 Delegating responsibility to private-sector service providers

Governments in many countries have outsourced some of the activities necessary to support provision of land administration services. The services that have been outsourced include:

- Notarization,
- Conveyancing,
- Cadastral surveying,
- Valuation,
- IT system development and maintenance.

The delegation of responsibility to private-sector service suppliers such as notaries and private cadastral surveyors can result in reduced cost to government in the provision of services, although it can increase costs to users. The private sector suppliers are intermediaries in the registration of properties and property transactions. Governments have used intermediaries to improve services. In New Zealand private lawyers acting for the parties in a property transaction lodge the transaction electronically. In the Republic of Georgia private authorized users accept documents for registration and transmit these to the Registrar. Cabo Verde is working on a system where the municipality and notary accept documents for registration and transmit these to the Registrar without the applicant for registration having to go to the Registrar.

The development of ICT systems to support private-sector intermediaries can be an important strategy in improving land administration services in general and in ensuring that transactions are recorded in the system. ICT applications have been developed in many countries to support lawyers and notaries in accessing land administration information and submitting transactions electronically. This occurs in both developed and developing systems. ICT applications have also been developed to provide private surveyor with access to digital data, to enable them to validate survey plans, and to electronically lodge survey data. The development of ICT modules for private sector intermediaries improves services, builds stakeholder confidence and trust in the system, and aligns with the FAO recommendations to adopt a modular approach in developing ICT systems (FAO, 2017).

The development and design of computerized Land IT Systems shifts the emphasis from paper documents to digital entry and certification of property data. In LIC/LMIC that have a tradition of notarization of property deeds, the development and design of the ICT system will facilitate the streamlining of this process. It will be important to engage private notaries and the local chamber of notaries in the reform process.

Private surveyors undertake cadastral surveys in most countries although some governments have retained cadastral surveying as a government responsibility (by the central government in Sweden, Netherlands and Finland, and local government in Norway, for example). While this can reduce the cost to government, it can mean significant additional costs to the person seeking land administration services. Where there is an established system of private surveyors it will also be important to engage

private survey associations and private surveyors in the reform process. Where there is not an established system of private surveyors some prerequisites are:

- The establishment of a body (board/council/committee or other body) to register and oversee private surveyors.
- Specifying the academic qualifications and professional experience required to be recognized as a private surveyor.
- Preparation and dissemination of instructions/directions that guide the practices of private surveyors.
- Establishing systems for private surveyors to have access to existing government records and information.
- Specifying the requirements and procedures for private surveyors to submit land records to the government and the procedures for government examination and acceptance of the records submitted by private surveyors.

5.2.3 Is there a role for crowdsourcing?

Gathering land administration information through a process of crowdsourcing is a strategy that has generated significant interest in the past decade. McLaren (2011a, 2011b) developed the concept as a key strategy in filling the tenure gap by registering the world's estimated 6 billion unregistered land parcels. The approach is based on recent experience in the generation of geographic data through crowdsourcing in support of natural disasters and public unrest (e.g. in Haiti and Libya) and the increasing power of readily available technology in smart phones with GNSS positioning and digital camera and video technology. McLaren identifies the key challenge to be ensuring the authenticity of crowdsourced land rights information. The response of land professionals such as cadastral surveyors to the innovative approach is also seen as a challenge. The crowdsourcing approach advocated by McLaren evolved into the technical platform provided by the Cadasta Foundation.

Haklay et al (2015), in reviewing experience in crowdsourcing geographic information for government use, identify 29 case studies. Many of these case studies relate to disaster reduction and recovery, the focus of their report, but the case studies include a wide variety of land administration applications including informal settlement mapping in Kenya and slum mapping in India. One of Haklay's co-authors, Basiouka, in her doctoral dissertation (Basiouka, 2015) extends the analysis of crowdsourcing to support the systematic compilation of the cadastre in Greece. The analysis found that the crowdsourcing approach was inexpensive, relatively quick, and flexible. However, it was found that government crowdsourcing projects should be well defined to reduce overlapping duties and responsibilities. In the case of Greece, it was difficult in the crowdsourcing approach to address the requirements to map forest, coastal zones and archaeological sites as preserved from private claims. Haklay (2015) sets out the best practices for crowdsourcing in government. These are:

- Clearly define the problem and solution parameters.
- Determine the level of commitment to outcomes and commit to communicating to the online community.
- Know the online community and their motivations.
- Invest in usable, stimulating, well-designed tools.
- Craft policies that consider the legal needs of the organization and the online community.
- Launch a promotional plan and a plan to grow and sustain the community.
- Be honest, transparent, and responsive.
- Be involved and share control.

- Acknowledge users and follow through on obligations.
- Assess the project from many angles.

The importance of ensuring government support for community-based approaches to gathering land administration data is illustrated in the experience of the World Bank-funded Reconstruction of Aceh Land Administration System Project in Indonesia. This project was designed to reconstruct land administration records and issue certificates in areas impacted by the December 2004 tsunami. A key strategy in this process was the implementation of a community driven adjudication process that was implemented with support from civil society. The Implementation Completion and Results Report for the project (World Bank, 2010) found that the project fell short in its objectives as the national land agency failed to fully utilize the records produced in the community driven approach as inputs to the formal systematic titling process.

The discussion above documents the status of crowdsourcing in capturing land administration data. Medici Land Government captured property data for about 50,000 properties in Lusaka in Zambia using a crowdsourcing approach.[50] There is potential, but the approach needs to be carefully designed with the government agencies to ensure that the data has legal authenticity, recognizing that in many countries the legal system is often not addressing the needs of the wider community. It is also important to note that there is no experience in using crowdsourcing techniques to capture land transactions. This limits the potential of crowdsourcing approaches under this study to develop toolkits to support decision making for investing in Land IT Systems.

5.2.4 Prerequisites and challenges to deliver LA services

The different strategies to reduce the cost of providing land administration services – whether they are legal or surveying services, whether they are first registration or transaction registration – may require and/or be driven by differing policy requirements, prerequisites in place, and necessary safeguards. Table 10 summarizes these, noting that for the purposes of this study, the strategy to gather land administration data through "crowdsourcing" has little relevance.

Table 10: Policy, advantages/disadvantages, and safeguards for alternative modes of delivery

Option	Policy requirements	Advantages/Disadvantages	Safeguards
Delegate responsibilities to local government	**Adequate Capacity** • Agreement to delegate responsibility **Very Low-Capacity/ Infrastructure** • Agreement to a low-technology approach	+ Responsibility assigned to prime user of spatial data + Reinforces principles of subsidiarity + Services closer to users – Requires clear definition of standards and guidelines – May require financial and technical support from central government – Not all local governments may have capacity/interest to assume responsibility – Requires oversight and guidance from national/regional government	**Adequate Capacity** • Quality control system such as system to license surveyors **Low-Capacity/ Infrastructure** • Guidelines for simple, clear procedures • Secure, low-cost land records systems with cross-indices • Capacity building • Public awareness and information

[50] https://www.mediciland.com/projects/

Option	Policy requirements	Advantages/Disadvantages	Safeguards
Delegate responsibilities to private sector service providers	• Adequate legal framework for public service outsourcing, concession arrangements, etc.	+ Reduced cost to central government + Private sector better placed to respond to market needs + Services more accessible to users – Need to establish oversight board/council – Requires clear specifications and instructions and ability to enforce these – Requires a process for private surveyors to access records and a system to examine submitted information – Possible increased costs to users	• Establishment of system to register and oversee notaries, lawyers and others providing land administration services • Establishment of body to register and oversee private surveyors • Formal audit and reporting structure
Crowdsourcing land administration data	• Legal and institutional basis for ensuring that crowdsourced data has authenticity	+ Build community and stakeholder support + Reduced cost to government in data capture – System needs to be established to ensure data authenticity – Difficulties in keeping the data updated (process to collect transaction data through crowdsourcing unproven) – Risk of raising expectations beyond ability to deliver	• Be involved and share control • Be honest, transparent, and responsive • Acknowledge users and follow through on obligations

5.3 Financing arrangements for delivering land administration services

Governments generate land-related revenue from land/property taxes and user fees and charges for the provision of land administration services. The land administration services that are typically provided by a land administration system include the registration of dealings in property rights (which may include transfer of rights by sale, inheritance, gift or exchange, the registration or discharge of a mortgage, the registration of an encumbrance such as a right-of-way or easement, etc.), the searching of land administration information, the provision of certified land administration information, the provision of value-added services such as reports of sales prices, valuation maps and tables, etc. These services are typically provided under an approved schedule of user fees and charges. The fees and charges payable are usually specified as a fixed fee but in some cases may be specified as an ad valorem fee (i.e. based on the property value). The land administration agency may also collect annual property taxes and payments for the leasing of public land. The revenue that can be generated is significant, typically more than the expenditure required to provide services and, although it may require specialist inputs, forecasting the future revenue from the provision of land services can be an important consideration for government in making a decision to invest in an improved Land IT System.

Based on global experience, users of land administration services are willing to pay for efficient, affordable, and timely land administration services, and land agencies can generate significant income from user fees and charges, if service provision is efficient and reliable. However, to be able to generate revenue from the provision of land administration services, the land administration system needs to provide the types of services that users require in the areas where users want land administration services. In many countries there is an initial investment required to develop the system to provide the services that users value and to conduct first registration to populate the Land IT system.

Many governments have adopted practices to allow land agencies to retain some or all the revenue from user fees and charges to fund some or all the expenditure required to provide land administration services. Self-financing agencies have been a success in the World Bank-funded land sector projects in the ECA region. Land administration agencies have been transformed into state-owned enterprises in many countries in Europe, North America, and Australasia. In most cases only part of the retained funds was required to fund the ongoing operations of the land administration agency.

The policy of allowing land agencies to retain some or all revenue is but one approach in using the revenue from user fees and charges to fund the provision of land administration services. Several companies have recently developed offerings of Land Administration as a Service (LAaaS) and governments have the option of using the revenue from the provision of services to offset or to fully fund the cost of accessing these LAaaS offerings. There has also been a lot of discussion of the potential for PPPs to support the provision of land administration services. Sharing the revenue from user fees and charges can be the basis for the payments to the private party for the provision of services under a PPP arrangement.

The following sections review:

- the potential revenue generated from user fees and charges and other revenue sources (leasing public land, land taxes) and increasing revenue by expanding geographic coverage of the registration system,
- two alternative strategies to finance the provision of land administration services:
    - Adopting a self-funding agency or authority model
    - Entering a PPP arrangement.

5.3.1 Potential land-related revenue

Potential Revenue from User Fees and Charges

The potential land administration revenue generated from user fees and charges will vary based on several inter-related factors, including:

- The completeness of the land administration system.
- The efficiency and accessibility of land administration services.
- The level of public perception and awareness of the benefits of registering property transactions.
- The affordability of the fees and charges for land administration services; and perhaps most importantly
- The level of land market activity and demand for such services.

If these factors are not in place, as they are not for many LIC/LMIC, there will be limited participation in the formal land administration system and thus high levels of informality in land markets. Some of these factors can be addressed in the short- to medium-term either through policy decisions (adjusting fees and charges) or through concerted action (re-engineering business processes, adopting service charters, and implementing comprehensive public awareness campaigns). Some factors require significant investment over the long-term (ensuring that the land administration system has broad geographic coverage).

The potential revenue that can be generated from the provision of land administration services can be assessed by looking at the situation in jurisdictions with well-developed land administration systems. Land Equity International (2014) in preparing the Costing and Financing of Land Administration Systems (CoFLAS) tool for GLTN, gathered information on annual land administration transactions and revenue in several jurisdictions that included jurisdictions with both well-developed

land administration systems and those with developing land administration systems. In the jurisdictions with well-developed land administration systems (Denmark, Netherlands, New Zealand, Peru, Sweden, and Thailand):

(a) The **property turnover** (registered transfer as a percentage of total registered properties) ranged from **3.0%** in the Netherlands **to 6.1%** in Sweden and was **4.9%** in Thailand with a register of over 34 million properties.

(b) **The revenue from registered transfers** as a percentage of total revenue ranged from **52.2% to 100%** of revenue (67.6% in the Netherlands, 100% in New Zealand, 52.2% in Peru, 54.0% in Sweden, 66.7% in Thailand).

(c) **The revenue from registered mortgages** as a percentage of total revenue was **30.9%** in the Netherlands, **32.9%** in Peru, **37.4%** in Sweden and **33.2%** in Thailand.

Although most land administration systems provide a variety of different services it seems clear that in many systems much of the revenue from user fees and charges comes from two categories of services, the transactions related to the registration of transfers and mortgages. The information provides some basis for projecting revenue under some assumptions on market activity.

The next critical issue is the affordability of fees and charges. Based on international experience, property owners seem prepared to accept transaction fees and charges up to about 5% of the property value. In the 2019 Doing Business report, 100 of the 213 jurisdictions assessed for the ease of registering property recorded the cost of a property transfer to be less than or equal to 5% of the property value.[51] There are countries with well-developed, well-used land administration systems that have higher cost of transfer as a percentage of property value. These include Japan (5.2%), Australia (5.4%), Netherlands (6.1%), Spain (6.1%), Taiwan (6.2%), Ireland (6.5%), Germany (6.6%), France (7.3%) and Hong Kong (7.7%). But virtually all the LIC/LMIC have been assessed in the Doing Business report with the cost of transfer significantly higher than 5% of property value.[52]

Setting high fees and charges may in theory generate strong revenue but high fees and charges can also have serious adverse consequences. If fees for the registration of transactions are set too high, there is increased risk of:

- informality as people opt out of the formal system,
- lack of reliable information on property values due to systemic under-declaration of property sale prices,
- corruption with officials seeking or accepting bribes in return for accepting low declared property values.

As noted above, it is generally accepted that the cost of registering a property transfer should be no more than 5% of the property value, although there are well-developed land administration systems that operate with costs as high as 7.7% of the property value. There is evidence to support this view.

[51] https://www.doingbusiness.org/en/data/exploretopics/registering-property

[52] These costs as a percentage of property value are those assessed by Doing Business. Only official costs required by law are recorded, including fees, transfer taxes, stamp duties and any other payment to the property registry, notaries, public agencies, or lawyers. Other taxes, such as capital gains tax or value added tax (VAT), are excluded from the cost measure. https://www.doingbusiness.org/en/methodology/registering-property The cost of real estate agents/brokers, which can be substantial in some jurisdictions, is also excluded.

Land Equity International (2014) looked at the transactions and revenue for some developing systems. Key information from this study, based on information collected in 2014, is set out in Table 11.

Table 11: Implications of fees and charges in some jurisdictions with developing systems

	Albania	Georgia	Lesotho	Peru	Thailand
Estimated number of properties (million)	4.0	3.2	0.4	n/a	36.2
Percentage of properties registered	75%	40%	4.3%	n/a	95.6%
Annual transfers/registered property	0.4%	5.9%	4.3%	1.7%	4.9%
Annual revenue as % of expenditure	239%	33%	39%	18%	1,363%
Cost of registering property transfer (Doing Business 2014)	11.1%	0.0%	8.7%	3.3%	6.3%

The figures for Thailand demonstrate the benefits of completing systematic registration and providing efficient land administration services, even with fees that are higher than generally accepted. Albania is operating under a policy of self-financing and has clearly set the fees too high. The impact of this is reflected in the low level of transfers per registered property.

Potential other Revenue Sources (Leasing Public Land, Land Taxes)

Many countries generate land-related revenue that is not transaction-based. These potential sources of revenue include revenue from the leasing of public land and annual property taxes. In many African countries land is by law considered to be state-owned, and the government levies an annual "ground rent" to land holders. Annual taxes and revenue from leasing public land have the advantage of being more predictable. However, leasing public land requires effort in establishing and enforcing contracts for leases, collecting lease payments, negotiating lease renewals, and having an accurate inventory of the lease assets so the State knows what is available to whom for what use. For land taxes to be equitable and effective the annual land tax system requires an investment in the preparation of valuation rolls/maps, the development of procedures and processes to assess property taxes based on specified tax rates, and efficient and effective procedures to collect the assessed taxes. Land tax can be assessed based on the income derived from the property, the area and use of the property, or on site, capital, or annual rental values. In many cases governments have difficulty in assessing values and simple (and perhaps simplistic) methods are often developed to assess taxes based on key characteristics such as property area, location, and land use. There are international standards for valuation, but these are often difficult to implement in a developing country. Bird and Slack (2003) document a comparative study of land and property tax in 25 countries and note that land and property tax is an important source of revenue at the sub-national level, but in the case of developing countries the contribution of property tax to sub-national revenue had decreased in the period from 1970 to 1990.

Increasing Revenue by Expanding Geographic Coverage

A key challenge faced by many LIC/LMIC is the limited geographic cover of the land administration system, so there is a need to increase that coverage through a program of registration, which commonly takes the form of a systematic approach. There is substantial experience in systematic registration and clear benchmarks for estimating the cost/property for first registration. The process for systematic registration is typically a participatory process where the government works directly or through a contractor to systematically engage with the community to:

- demarcate and survey or map property boundaries,
- gather information and adjudicate property rights,

- prepare adjudication records (maps and lists of names) for public display,
- collect and address any requests for correction or objection to the publicly displayed adjudication record,
- register the resulting records and distribute titles/certificates to property owners.

The costs of this process typically range from about US$10 to US$50/property or more, depending on the approach adopted for surveying and mapping and the effort required to adjudicate the rights. The cost of first registration is typically underwritten by government as charging a fee can be a barrier to participation. There is a substantial cost in undertaking first registration. The process is also very participatory, with trained personnel working for extended periods in the field, and this requires significant resources and takes time.

The geographic cover of the existing land administration system is a factor that needs to be considered in looking at an investment in Land IT Systems. Success with some strategic options (adopting a policy of self-financing and implementing PPPs) seem predicated on having good geographic coverage. Poor geographic coverage does not restrict consideration of investments in areas where there is good geographic coverage. A model that has evolved where the country-wide land administration system is limited in coverage and/or lacking in reliable records is the local land registers that service local needs (Baldwin et al, 2018). These registers can provide a good basis for providing land administration services at sub-national levels (cities, municipalities, districts, etc.). Expanding geographic coverage through a PPP is an option and is discussed below in section 5.3.3.

5.3.2 Adopting a self-financing agency model

Key difficulties faced by land administration agencies in LIC/LMIC are reliance on inefficient, time-consuming and outdated procedures, and the lack of adequate funding to produce and deliver services, to develop and maintain the fundamental systems necessary to provide services (land records management systems, ICT systems, geodetic reference frames etc.), and to develop the human resources and capacity necessary to be able to provide efficient services. These problems are not restricted to the land administration agencies and typically apply to all agencies that provide services to citizens.

However, based on international experience, an efficient land administration agency that provides services that are affordable and valued by users can generate significant revenue from user fees and charges, typically much more than the expenditure necessary to maintain the systems and provide services to government and users. One strategy that has been adopted to address the difficulties highlighted above is to restructure the land agencies as semi-autonomous agencies with some degree of freedom from standard civil service and other government rules and procedures, and with the flexibility to adopt new practices and approaches under an arrangement where the agencies can retain some or all the revenue generated from user fees and charges. Many of the land administration agencies that were established after the fall of the Soviet Union were established under a policy of self-financing, where the agency was expected at some specified date in the medium-term to be generating sufficient funds from user fees and charges to cover the full ongoing operational expenditure of the agency.

Land administration agencies have been transformed into state-owned enterprises in many countries in Europe, North America, and Australasia. In most cases only part of the retained funds is needed to fund the agency, although in some cases governments provide budget support for services that are deemed to have a public good, such as the maintenance of key registers or the provision of fundamental datasets. These enterprises are usually established with a supervisory board, possibly with user representatives, that typically sets service targets and approves the schedule of user fees and charges, and annual business plans and budgets. The setting of fees is an important role that cannot be left to the agency. The fees need to be affordable and not a barrier to participation.

As mentioned above, self-financing agencies have generally been a success in the World Bank-funded land sector projects in the ECA region. Where an IT supplier gained access to a share of revenue there has been little or no problem with sustainability. There has however been challenges where successful self-financing agencies have been converted back into budget financed agencies despite a track record of having provided efficient services. This has happened in Lithuania and Romania.

Princeton University (2018) summarizes case studies of variations of such arrangements in Ontario (Canada), Western Australia, Jamaica, Kyrgyzstan, and Rwanda. The creation of Landgate in Western Australia as a statutory authority gave the agency the flexibility to develop a new ICT system, after a past failure to develop such a system, in a partnership with a private IT company. This was significant as the new ICT system was developed at time when revenues were low due to a depressed property market (Princeton University, 2017).

Princeton University (2018) list some of the prerequisites and challenges for such an approach. The approach:

- depends on a reasonably large and active formal property market to generate enough revenue,
- requires a clear division of responsibility, particularly where there is an expectation that non-revenue generating functions continue,
- must address conflicts of interest between a public role and the need to generate revenue,
- must recognize that it is likely to take time for staff to accustom themselves to new ways of working.

5.3.3 Public-private partnerships

The PPP model emerged in the 1990s as governments developed and implemented long-term collaborative arrangements with the private sector to develop infrastructure and provide services. There are common guiding principles and precepts that countries with successful PPP programs adopt.[53] These principles and precepts require deeper understanding when applied to land administration systems. PPPs in land administration (Land PPPs) are not new, but there are considerable barriers to their implementation in LIC/LMIC, not the least of which is the limited number of successful examples.

Many governments are exploring private sector financing for services that they have difficulty in funding through traditional government budget allocations. Under a PPP arrangement, private operators often provide upfront capital to fund land administration system improvements for which the government itself does not have the budget. Under this type of PPP arrangement, the private operator then earns a return on its capital by the fees charged for land administration services using the improved system. There are clear advantages in implementing a PPP to provide land administration services, and these include:

- The ability to bring capital and finance to improvements, technology, modernization, and updates.
- The ability to maximize efficiencies and cost savings through private-sector know-how and management practices, and to reduce the time to market for the functional system.

[53] For example, information available from the World Bank - https://www.worldbank.org/en/topic/publicprivatepartnerships

- Increased flexibility of land administration services (and in particular land registration services).
- Improved customer orientation of land administration services.
- Mutual economic benefits (outsourcing of work, delivery of value-added services) through appropriate business models, development of new market segments.

The PPP payment mechanisms typically include some or all the following:

- user charges payment, collected through a special purpose vehicle from users,
- government payment for services or assets based on:
    - usage (primarily output-based subsidies),
    - availability (dependent on asset or services meeting specified standards),
    - up-front subsidies (typically specified as payments linked to specified milestones),
- bonuses, penalties, or fines due as specified outputs or associated standards are or are not met.

In the context of land administration, an alternative to project funding and revenue generation through user-pays arrangements is the use of availability payments. Such a payment mechanism requires that the private partner provide and administer infrastructure for public authorities. Compensation for this is provided through regular payments based on the level and, depending on the terms, quality of service. Land administration PPP payments can also take the form of a fixed capacity payment (unlinked to the number of service transactions) or a variable payment linked to the actual number of transactions. In land administration, this could occur in a contract to build, manage, and finance property registration in defined areas, which would be compensated using an availability payment per transaction to cover the total project cost – including financing and investor returns. This approach has been adopted in other countries for public infrastructure and services, for instance, health, motor vehicle registration, ICT facilities, and more traditional tolled facilities such as roads.

The three standard PPP revenue flows listed above may not be sufficient to make a PPP viable and there may be a requirement for viability gap financing that might be provided by a development partner. In a situation where a government was interested in a PPP arrangement, but first needs to complete first registration or digitization of records work, a development partner might be able to fill that gap by funding the first registration or digitization work with the private operator establishing the land information and transaction system that would provide land administration services under the PPP arrangement.

In countries with land administration systems in their nascent stages, the collection of land administration service fees is often very challenging – particularly where a culture of formal land registration has not been established – and revenue generation from user payments may be seen as a payment risk by the private sector, particularly the institutions providing finance for the PPP. Consequently, availability payments may provide better options for exploration in terms of reducing private party risk and promoting social benefits such as pro-poor accessibility.

In countries with less well-developed land administration systems, procedures to record rights are often incomplete in terms of geographic coverage and information datasets. These incomplete records make it impossible to consider recovering the cost of land services from user fees and charges in a manner that is not a major barrier for participation in the formal system, particularly for the poor and vulnerable. The lack of complete coverage can also be a barrier for a PPP arrangement as the opportunity is unlikely to be viable for a service provider with the fees set at a level that is acceptable to users unless the scope of the PPP is restricted to geographic areas where the LAS is complete. In some countries land administration services are provided at a sub-national level or jurisdiction. If

records are complete or near complete in a jurisdiction then a Land PPP at the jurisdiction level may be a viable option.

The prerequisites for considering a Land PPP include:

- There is political agreement to proceed with a PPP.
- There is a clear statement of what the project aims to achieve supported by an assessment of the tangible economic benefits and assessments of the potential financial and social impacts.
- The institutional arrangements and mandates (including the existing agreements with other agencies, local governments, private sector service providers (notaries, surveyors, etc.)) are adequate enough or sufficient to attract a private operator under a PPP arrangement and there is a clear definition of roles and responsibilities.
- The projected demand for the services and whether this demand is enough to justify the project.
- The services that are to be provided under the PPP are services that can be provided by a PPP operator under the existing legal framework or the legal framework can be changed with relative ease.
- The capital investment required by the PPP operator and the annual running costs are specified (by type and cost).
- The projected transactions and revenue are specified and substantiated by historical data and reasonable assumptions.

The effort required for the financial data/financial modeling necessary to attract an investor to a PPP is extensive. This important prerequisite might be a task that could be undertaken by a development partner so that a PPP project might be tendered if appropriate.

5.3.4 Prerequisites and challenges of financing strategies

The different strategies to use revenue from the provision of land administration services to fund reform and ensure sustainability may require and/or be driven by differing policy requirements, prerequisites in place, and necessary safeguards. Table 12 summarizes these.

Table 12: Prerequisites/challenges for alternative strategies to finance land administration service

Strategy to use Revenue	Policy requirements	Other prerequisites	Safeguards
Adopt a self-financing model	• Agreement to retain some/all revenue	• Large and active formal property market and/or commitment from Government to fund any shortfall in revenue from user fees and charges • Staff may require time to accustom themselves to new operating methods	• Clear division of responsibilities • Address potential conflicts of interest[54]

[54] Conflict of interest may arise, for example, between a focus of generating revenue from land market activity and other government policy objectives such as limiting market activity and/or prices, environmental protection, etc.

Strategy to use Revenue	Policy requirements	Other prerequisites	Safeguards
Implement a PPP	• Agreement to a PPP	• Clear statement of aims, tangible economic benefits, potential financial and social impacts • Institutional arrangements and mandates conducive, and roles and responsibilities are clear • Project demand justifies the project • Services can be provided by PPP operator under existing legal framework • Capital investment and ongoing annual costs are clearly specified • Projected transactions and revenue are specified based on historical data	• Clear KPIs for operator • Data security standards for cloud storage (if necessary) • Formal audit and reporting structure • Ability to escrow funds (if necessary) • Ability to repatriate funds without penalty (as appropriate) • Government/sovereign/sub-sovereign guaranty (in some cases) • Contract managed through PPP lifecycle

Based on the discussion on land-related revenue and the identified prerequisites for alternative modes of service delivery set out above it seems prudent that a development partner looking at investing in Land IT Systems confirms or seeks agreement on the following matters:

- A policy of self-financing for the agency providing land administration services with the agency able to retain fees and charges to operate as an autonomous agency with appropriate governance arrangements. This policy should ideally be agreed prior to the agreement on the investment and implemented at an appropriate stage during project implementation.
- The importance of public awareness and information as a means of maximizing public participation in the registration of transactions, and the possible inclusion of support for raising public awareness and information in the scope of the proposed investment in a Land IT System.
- The fees and charges are adequate to achieve self-financing in a realistic timeframe, but still are affordable to users.
- The business processes are efficient, adequately resourced, and funded, and accessible to users

The option of adopting the various strategies will depend on several factors, including the government's fiscal situation, the coverage of the system, the amount of data in digital form, and the annual number of transactions and amount of revenue generated by the land administration system. It will be difficult to adopt some of the strategies to use retained revenue to fund reform, particularly the PPP option, in the typical 5-year development project timeframe. This really means that any decisions on moving to alternative delivery arrangements should focus on the prerequisites listed in Table 12. Policy makers in government will also typically want to see evidence of past success and this may dictate a phased approach.

A further investigation of alternative modes of delivery with respect to the advantages and disadvantages of each strategy is shown in Table 13.

Table 13: Advantages/disadvantages of alternative strategies to finance LA service

Option/ Requirement	Advantages	Disadvantages
Adopt a self-financing model	• Security in financing through retained revenues • Ability to retain key staff by offering attractive packages • Flexibility in sourcing technology and ICT • Agility through private sector practices (business plan, annual budgets, service charter, etc.)	• Requires reasonably large active land market • Requires clear division of roles and responsibilities • Must address conflicts of interest • Staff will need time to adjust to new ways of working
Implement a PPP	• Access to capital and finance • Ability to optimize cost savings through private sector practices • Increased flexibility in provision of services • Improved customer satisfaction • Mutual economic benefits	• Requires reasonably large active land market • Projected demand for services must justify investment • Requires clear division of roles and responsibilities • Must address conflicts of interest • Staff will need time to adjust to new ways of working • Difficult to build registry without subsidies

6 Design principles and checklists

There are well established principles for the design and implementation of programs to improve the provision of land administration services and invest in Land IT Systems. The general principles include the following key elements:

- There is enough demand by users and a market for the services provided by the system.
- The system is to be "fit-for-purpose" with system complexity aligned to demand, needs, capacity, and conditions (users, resources, power/Internet, etc.).
- The system is designed for current needs but should have the ability to expand in response to new uses and locations through appropriate interoperability measures that ensure key information is accessible widely and is authoritative.
- There must be human capacity to use the system and this requires more than training.
- The system must be sustainable, scalable, and secure – meaning that there is sufficient funding and/or a plan for self-financing, sufficient market demand, and sufficient capacity and planning to maintain the system.

These current practices and design principles provide an important foundation for land IT investment; however, they do not provide enough detail to sufficiently inform experts and decision-makers. This need for further detail could be provided via a specific and comprehensive toolkit that guides the assessment of, and potential scoping for, investments in Land IT Systems.

6.1 Planning for sustainability[55]

It is essential to make sure that a computerized land administration system can continue to operate within an organization beyond the end of any once-off funded technical assistance project to design, build and implement a new computerized system. Whereas the design, build and implement project is often the responsibility of a third party external to the agency, the ongoing system operation remains the responsibility of the agency and cannot be ignored. Computerized systems in land administration agencies generally evolve to include support for core land administration functions (and related transaction processing such as for property registration and the updating of the cadastre) and as such become "mission critical". Key sustainability concerns are in the following areas:

- **Financial**, whether the organization can afford to pay software license and maintenance fees, to recruit system support staff, and to cover the operational costs of a computerized system like Internet connectivity and printer consumables.
- **Undue dependency** on specialist local staff, external (including international) consultants, software companies, land administration functions as a service provider and on specific items of equipment.
- Software **usability** in that the software is easy to use and intuitive and hence more likely that land agency staff will continue to use it, and the system will operate efficiently and as designed.
- Software **robustness** in that the software is well structured and documented and thoroughly tested.
- Software **maintainability** in that software fixes can be made quickly.

[55] Based on commentary from draft version of "Technical Guide for Enabling Technologies in Land Administration", FAO, Rome (2016) – unpublished.

- Software (or Functions as a Service) **extendibility** in that any future software or service functionality required by the agency can be achieved in a reasonable timeframe and cost.

Measures that a land administration agency can put in place to address these system sustainability concerns are discussed below.

6.1.1 Strengthening capacity

Finding people with the skills and knowledge to establish and maintain computer networks and IT systems can be a real challenge, especially when the local market only supports a limited pool of trained IT technicians. Often overseas experts or contractors from other regions are brought in to fill the gaps, but this tends to be a temporary solution that is seldom sustainable in the longer term. Building capacity through targeted capacity development interventions that recognize and accommodate local resourcing and skills constraints is a key determinant for ensuring the sustainability of computerized systems. Partnering or engaging with local universities or technical schools can also build local capacity.

Most development agencies recognize capacity development as a core objective on the projects they engage in to ensure projects continue to deliver benefits in the long-term. A key outcome in Uganda from the initial DFID work in supporting the government to develop a national land sector strategic plan, creating the Land Act 1998, to reform land registries and to pilot systematic registration (plus follow-up activity under the World Bank projects) was the preparation and support for a comprehensive Training and Capacity Building Plan that also built links to universities. In Rwanda, a 10-year training plan was prepared, and 60 staff received post-graduate university degrees. In some countries there are dedicated capacity development centers that actively promote alignment with national needs and priorities, and the use of local expertise. There is also recognition that there is not a one size fits all approach and that capacity development must be more than just up-skilling individuals through training. To successfully achieve capacity development the focus must be on strengthening capacity using a range of interventions at multiple levels that include the individual (individual professional development plans, tools and training), the organization (restructuring and/or revision of business processes and operating procedures) and the institutional environment (pay, promotion and culture). It does take time for some interventions to reach their full potential, but the benefits gained from achieving a sustainable outcome more than justify the time and effort invested.

6.1.2 Adequate funding

Land administration agencies are structured and organized in many ways. In most cases they are part of line ministries and as such are subject to the public sector financial management and budget planning and approval regimes that operate in a country. In these cases, the central government allocates budget resources for the operation of the land administration agency. In other cases, public sector reform has resulted in some countries adopting financial management regimes similar to those used in the private sector, where fees earned from services are retained and used by the agency to fund operations and system sustainability costs. Adopting a self-funding model typically requires that the agency assets (such as computerized systems) are included within a balance sheet and recognizes depreciation within budgets. Where computerized systems are treated as assets, depreciation helps to ensure funds are available to replace a system as it ages and no longer meets the organization's needs.

Another mechanism that can be used to help fund both day-to-day operational costs and system development costs is a model for the determination of and then the update of land administration service fees to reflect those costs. If the agency can obtain government approval of the model as the means to determine fees and in addition to hold onto and carry over all or part of land administration fees collected, this is a useful way to ensure the necessary funding is available for "mission critical" systems.

Should neither of these measures be available to an agency, then the agency needs to closely monitor system operating costs, government funding for the land administration agency, revenue from user

fees and charges, demand for land administration services, and review predicted IT investments. Based on these, they need to provide timely and well documented inputs into the budget planning regime on the funding needs for their computerized land administration systems not just focusing on the next financial year but on at least the next 5 years, if that is possible. Coupled with these budget planning inputs they should be briefing ministers, boards, and the agencies responsible for the review and approval of public sector budgets on the necessity of adequate funding for their systems and the consequences if funding is not available.

6.1.3 Strong and secure IT infrastructure

To ensure critical items of equipment do not fail and disrupt the service provided by the computerized land administration system it is wise to ensure there is a certain degree of redundancy with respect to these items of equipment (for instance, scanners and printers (typically in front office areas) and routers and switches in the server room). If possible, it might also be useful to cover critical office areas with wireless connectivity and ensure workstations in those areas are wireless capable.

Another area of vulnerability is the introduction of computer viruses and so all computers need to be protected by anti-virus software that is regularly updated. Staff also need to know what data and software (if any) can and cannot be loaded onto agency computers, acceptable email practices and, if Internet is available, what is acceptable behavior with respect to Internet use. Ideally the agency's system administrator should block access to social media and other sites not required for work purposes.

Where the computerized land administration system is connected to the Internet, other measures such as a firewall and enforced user password changes should be implemented to ensure the system is secure from external threats including hacking.

6.1.4 Improvements to business processes

Business process improvement is a natural consequence of computerization in land administration agencies, and it becomes more important as computerized systems become an integral part of mission critical functions and processes. Previously land administration systems were based on paper-based processes and so there is a need to complete the process of digitizing all "active" land records, which allows the agency to "go digital" and dispense with paper-based processing. As agencies gain confidence in how computerized systems work in a land administration context not only will they see opportunities to simplify processes to take advantage of technology, but they will also identify new vulnerabilities. When a vulnerability is identified the risk should be assessed in so far as the possible impact and the likelihood of the risk eventuating. Knowing the nature of the risk, appropriate processes and mechanisms can be implemented to mitigate these risks. Furthermore, it is critical that the existing processes and procedures not be simply "computerized", but rather re-engineered to ensure legal/regulatory compliance and streamlined business operations.

6.1.5 Recognizing the need for user demand and incentives

When investing in a Land IT System, it is important that the officials using the system have an incentive to use the system and that any political economy issues related to changing long-established land administration procedures and approaches have been sorted adequately. Strategies to do this successfully include building linkages to champions at key levels (policy, ministry, department, land office, etc.), involving staff in system design and deployment, fostering good training and career development opportunities, adopting a service charter supported by an effective customer feedback/complaints system and recruiting a cadre of new staff. The land agency needs to have clear metrics that promote good service, build community support and participation, and foster strong public interest and demand for services.

6.2 Decisions and risks of investing in Land IT System improvements

The eventual Assessment and Design toolkit is to provide a decision matrix that guides the processes of scoping and costing of potential land information and transaction system investments in partner

countries to address the identified land-related problems and/or land-related needs. Key elements that will underpin the toolkit include:

- An assessment of the risks of improving the provision of land administration services by investing in a Land IT System in a specified context and possible strategies to mitigate these risks.
- The decision-making process to invest in a Land IT System based on guidelines for "calculated risk taking", which may result in the phasing of the design and deployment of the Land IT System or, where it is decided that it is too risky to invest in a complex Land IT System, the design and costing of incremental steps to improve land administration services and set the schedule for future land IT investments.

The two elements are discussed in the following sections.

6.2.1 Risks of investing

Improving the provision of land administration services by investing in Land IT Systems in a LIC/LMIC faces a range of risks. The risks include the typical risks of investing in information technology, which include issues arising from unclear and changing scope, schedule, resources, and technology. There will be risks related to the general institutional and budget allocation context, which will include issues such as: gaps and inconsistencies in the policy, legislative and institutional frameworks; under-resourced offices, incomplete and poorly maintained land records systems; complex procedures; poor public participation; and limited human and other resources. The 5-year timeframe of MCC compacts also imposes challenges.

There are different perspectives on the risks of investing in Land IT Systems. Some of the critical risks from the perspective of several key stakeholders are summarized in Table 14. Many of these risks need to be addressed upfront in the discussions between government and the development partner in the identification and design stages of the project. Other risks, such as many of the risks listed below for the providers, can and should be addressed as the project is implemented. Another set of risks will arise after the project is completed and where possible should be anticipated and mitigated. This paper focuses on the risks that need to be considered in the identification and design of a Land IT System.

Table 14: Major risks of investing in Land IT Systems from the perspective of the key stakeholders

Government (Policymaker)	**Government** (land agency)	**Development Partner** (financier)	**Provider** (contractor)
• Policy coherence (land policy, e-Governance, etc.) • Effecting necessary changes in policy and legislation • Financial commitments • Short-term results (before next election)	• Impact on statutory responsibilities and reporting requirements • Feasibility of successfully completing project • Change management and behavior change related to new systems and procedures within the agency • Assurance of ongoing financial support	• Sustainability • Reputation • Compliance with procedures and safeguards • Coordination with other DPs • Ability to complete project in set timeframe	• Getting paid • Stability of government • Exchange rate fluctuations • Use of government infrastructure • Government commitments (staff, office, funds, etc.) • Clear hand-over of the Land IT System to the agency.

The following table has been prepared based on the review of the current state of play of investing in Land IT Systems as set out in this document and the stakeholder feedback from the consultations on the draft document. The risks listed in the table are the key risks that need to be addressed in assessing and scoping investments in Land IT Systems. The risks have been grouped under the topics of: 1. Policy and Legal Framework; 2. Institutional Framework; 3. Technology; 4. Financial Analysis; and 5. Sustainability.

The risk analysis set out in Table 15 will be central to the decision matrix in the Assessment and Design toolkit that will guide the processes of scoping and costing a potential investment in a Land IT System. The third column in Table 15 sets out possible mitigating strategies that could be adopted in designing the potential investment. MCC has various stages in its activity cycle and the mitigating strategies can be implemented at different stages, including:

- during diligence and design stages for a compact or threshold program, or
- during project implementation where a land activity has been defined as starting with a restricted scope or geographic coverage that could progress to a wider scope of activities or coverage where specified key results or milestones are achieved.

Table 15: Key risks in investing in land administration reform and Land IT Systems

Risk	Key Questions/Measures	Possible Design Mitigation Strategy
1. Policy and Legal Framework		
Political economy risks that cannot be managed	• How is the country rated on Transparency International's corruption index? • Do articles on high-level rent-seeking in the land sector feature in the media? • Do senior officials in the land agency have the incentive to adopt and maintain a new Land IT System? • Do front-line users and technical officials have incentives to utilize new procedures and systems?	• Seek high-level champion • Possible high-level preparatory activity – Land Governance Assessment Framework (LGAF), land policy, etc. • Seek to build links to policymakers • Design could provide platform for policy formulation
Insufficient high-level political will for reform	• Is there a policy level spokesperson for reform (Ministerial level or higher)? • Is there a high-level document setting out a reform agenda in the land sector? • Is the key land sector legislation up-to-date?	• Seek champions at multi-levels (policy, head of agency, technical) • Possible high-level preparatory activity – LGAF, land policy, legal analysis
Policy and legal framework for land sector reform is not in place to support an investment in a Land IT System	• Property disputes do not form a major part of judicial court cases • The institutional mandate for maintenance of Land IT Systems is clear • % of population whose property rights are recognized by law	• Possible high-level preparatory activity – LGAF, land policy, legal analysis

Risk	Key Questions/Measures	Possible Design Mitigation Strategy
2. Institutional Framework		
Lack of buy-in and capacity at the institutional level and an incentive system that favors the "flexibility" of the current manual system	• Do the key organizations providing services (survey, registration, valuation etc.) operate as silos? • How many systems (rural/urban, many cadastres, etc.) exist? • Is there a willingness to discuss change/BPR? • Is the proposed project seen as just an IT project? • Do front-line officials have incentives to adopt and use new systems?	• Identify and foster champions in the land agency • Possible preparatory activity – preparation of business plan (including OMO, HR and training needs assessment (TNA), restoration and digitization of records, investment in low-technology or simple record-keeping solutions, BPR
Poor land records management system(s)	• Are the land records systems well maintained with little or no problems with lost or damaged records? • Can land records be accessed in a timely manner by those providing land administration services? • Is the land records management system supported by an existing IT system (at least a key index related to property, right/document, right holder)?	• Possible preparatory activity – restoration and digitization of records, etc.
Inefficient land administration business processes	• Are land administration transactions completed (and registered where appropriate) in a short-time frame and require few visits to the office responsible for processing the transaction? • Are the steps involved in processing land administration transactions clearly displayed in the offices processing these transactions? • Is there a clear promise on the time, costs, and outputs from the process to register a land administration transaction? • Does the requirement for multiple approvals by officials create inefficiencies? • How many complaints are there from those seeking to register a property transaction?	• Possible preparatory activity – e.g. BPR
Limited geographic coverage of land administration system	• Does the institution with the mandate have the capacity to serve property owners throughout the country? • How many properties are registered? • Has an estimate been prepared for the number of properties that should be registered? • What % of the country has been registered? • If first registration is not complete, is there a plan to complete first registration and is this plan costed?	• Possible preparatory activity – preparation of national plan to complete first registration, etc. • The design might consider phasing investment, prioritizing areas with good coverage

Risk	Key Questions/Measures	Possible Design Mitigation Strategy
3. Technology		
Poor or unclear proposal for investment in a Land IT System	• Is there a clear description of the scope of the proposed Land IT System? • Is the proposal costed? • Does the proposed ICT system scope provide solutions to land administration requirements outlined earlier in this table? • Is the proposed technology proven, scalable, affordable, readily extendible, involves an achievable level of software development (including software customization), is able to be supported locally, and does the technology support the improved delivery of specified land administration functions and services with resources (including staff resources) available to the agency? • Have all applicable vulnerabilities in the proposed locations where the Land IT System will be located and where it will provide services been identified, and have mitigating features and actions incorporated into the system design and implementation planning? • Is there insistence that any Land IT System must be built on existing government IT infrastructure? • If so, has this requirement created difficulties in the past?	• Possible preparatory activity – preparation of detailed, costed Land IT proposal, etc. • Consideration of a simple/low-technology information and records management approach to improve an existing manual records system (such as preparing records for digitization, digitizing cadastral mapping and land records, generation of indices, etc.) • Ensure agency can specify functional requirements or has assistance to do so
Failure to integrate Land IT System into daily workflows	• Does the existing Land IT System operate in parallel with manual system? • Is the existing Land IT System operating in all land offices? • Does the proposal for the new Land IT System integrate the system into daily workflows?	• Document existing business processes and prepare strategy for BPR that integrates IT in process • Integration of Land IT System discussed and agreed with government during design
Appropriate staff are not available to take on critical roles in the project to develop and implement the proposed Land IT System	• Does the proposal for the Land IT System document the staff required to support the project and their qualifications? • Has the agency identified any personnel for assignment to the proposed project, particularly the team leaders? • Is there a strategy to identify, recruit and train the staff needed to support (and potentially develop) the proposed Land IT System?	• Possible preparatory activity – preparation of detailed staffing plan for the proposed Land IT System

Risk	Key Questions/Measures	Possible Design Mitigation Strategy
Failure to provide appropriate office facilities to accommodate proposed Land IT System	• Is the office space identified for the proposed Land IT System servers, secure, air-conditioned and with adequate power? • Is there a LAN cabling plan covering all offices and staff who will use the Land IT System including staff who approve or register land administration transactions? Network devices (printers and scanners) also need LAN connections. • What additional office furniture will be required? • What additional power outlets will be required in all offices? • What changes need to be made to public counters? • What changes need to be made to (paper) record archive office space? • What funding is available for this office renovation work?	• The design will need to identify the necessary office accommodation for the proposed Land IT System if this is not already documented
Inadequate nationwide infrastructure (electricity, dedicated communication links, Internet connectivity) to support the operation of the proposed Land IT System	• What levels of service are available and where? • How reliable are these service in different locations? • What are the costs of these services and are they like to change? • What backup or alternative services are available?	• Where there are reliability or coverage limitations, backup or alternative arrangements and business processes must be designed and costed as part of design of the total Land IT System solution
4. Financial Analysis		
Insufficient willingness to pay for or demand services	• Is information available on recent annual transactions/revenue? • How does the level of transactions compare with global benchmarks? • Is there information on customer complaints? • Is there an efficient system to respond to complaints?	• Investigate and document past transactions and revenue • Conduct comprehensive stakeholder analysis • Investigate action needed to improve participation (fees and charges, BPR, access, etc.) • Consider a low-technology/low resource approach for a land information and transaction management system • Prepare strategy to foster participation
Failure to align revenue with costs	• Is information available on annual expenditure (broken down by type and location)? • Are annual budgets prepared by indexing previous budget requests or are they based on a costed strategic plan? • Is information available on the fees and charges collected by the agency (broken down by type and location)? • Is the land agency able to retain part of the fees and changes collected from users to support the provision of services?	• Possible preparatory activity – preparation of detailed fiscal model to cost out land administration services

Risk	Key Questions/Measures	Possible Design Mitigation Strategy
Inability/unwillingness of government to fund operations and maintenance	• Does the current Land IT System have a support and maintenance contract? • What expenditure in recent years has there been on IT support and maintenance?	• Prepare strategy to strengthen IT (operations and maintenance (O&M), desktop support, etc.) drawing on best government IT experience
5. Sustainability		
Loss of trained staff and qualified technicians	• What information is available from the existing HR system and HR records in the land agency? • Is there a training plan and/or records on training provided? • What percentage of approved positions in land agency are filled? • What is the staff turnover (particularly in IT)?	• Design will need to consider HR strategy, may require a training needs analysis (TNA), and will include a comprehensive training plan • Consider a low-technology/low resource approach for a land information and transaction management system
Lack of investment by government in the provision of land administration services	• What percentage of approved positions in the agency providing land administration services are filled? • What percentage of the budget request is allocated? • Is the budget allocation provided in a timely manner? • Does the approved budget for the agency providing land administration services include significant non-salary investments in areas such as first registration, positioning and mapping, computerization, etc.?	• The design will need to seek a commitment from government to fund the sector by budget allocation or through alternative means such as the retention of fees and changes

6.2.2 Scoping Land IT System reform

The eventual Assessment and Design toolkit will be structured to guide decisions on investments based on clearly specified guidelines for “calculated risk taking” that focus on the role of or necessity of technology in solving the identified land-related problems.

One alternative strategy to the investment in a comprehensive Land IT System is the phasing of the activity, with the activity prioritized to areas where the underlying circumstances are most conducive to a successful outcome. All well-developed land administration systems have typically evolved from simple systems that address the needs of a localized area and over time these systems have gradually added services and extended geographic coverage to respond to increased demand for services using proven processes and systems and strengthened capacity.

There is an increased focus in recent years on institutions close to the community. Technology provides the means to develop robust local Land IT Systems in a very participatory manner that builds local capacity. Baldwin, et al (2018) details examples of such systems in Ethiopia and Tanzania. In both these countries, robust, simple systems were developed to fill a gap in the development of a comprehensive national Land IT System. The key risks in developing local systems and local pilots is both sustainability and the potential future difficulty in integrating different datasets into a national system as it evolves. The initial local systems should be designed as an interim system with the data in a form that can be readily integrated into the national system when it is available.

A project could be designed to develop a comprehensive Land IT System in a defined geographic area, with provision to expand the system to other areas if the initial activity is successfully completed. The defined geographic area could be selected based on a range of criteria such as local capacity, evidence

of demand for services, land market activity, availability of IT/communications technology, regions of economic or other agreed priorities, etc. The phasing of activity will be a challenge in a 5-year compact timeframe. The Assessment and Design toolkit needs to recognize that investment in a Land IT System may be phased.

In many countries there are high costs in accessing technology and the Internet, and there is a shortage of resources and capacity to design, develop and maintain sophisticated IT systems. Examples of this include:

- record keeping in contexts where land rights registration has been decentralized to local level officials, including in highly rural environments, where financial resources, IT skills, and Internet/electricity are limited, etc.,
- record keeping and transaction management inside irrigation perimeters, where land management is the responsibility of local officials and not connected to other systems.

The use of the eventual Assessment and Design toolkit may result in a decision that the risks of investing in a highly complex Land IT System in a specific context are too high, but that there is a good case for simpler or alternative investments that address the information, records and transaction dimensions of the identified land-related problems. The Assessment and Design toolkit will need to support this.

There are simpler systems approaches or alternative investments that improve the provision of land administration services and provide the foundation for a future investment in Land IT Systems. These alternatives could include investments to:

- Improve the existing land records system by:
    - Restoring, scanning, and digitizing/key data entry of existing manual records,
    - Creating cross-indices to improve efficiency in the provision of land administration services (indices relating persons and properties to key types of records such as transactions/deeds, survey plans/records, property valuation/tax rolls, etc.), preferable in digital form,
    - Linking existing land records to a new series of manual or digital cadastral maps.
- Re-engineer business processes.
- Strengthen capacity and invest in education, training institutions and professional associations.
- Preparation of business plans to support a shift from a focus on process and legal requirements to a focus on customer needs and requirements, and scoping for future system investments to support this.
- Raising public awareness and educating the public on land administration procedures and the benefits of participating in the formal system.

The Assessment and Design toolkit needs to be sensitive to the challenges of working in low-technology/low-complexity contexts and be able to support the design of simpler or alternative investment strategies that address the identified land-related problems, maintain engagement with government, support the overall MCC objectives in the country, and lay the foundation for future investment in a Land IT System.

7 Conceptualizing the assessment and design toolkit and conclusions

The Assessment and Design toolkit is to be developed based on the final State of Practice Paper, the requirements set out in the Scope of Work (SOW) and input from MCC's LAE practice. The toolkit will be framed in such a way that it can be applied by MCC's land experts themselves and lead to decisions on Land IT investments. The toolkit will support project design, either as part of compact development or as part of project scoping, and it will also support MCC's oversight of the development of specifications for system design during compact implementation.

7.1 Assessment and design toolkit

The following table sets out the requirements for the Assessment and Design toolkit as set out in the scope of work (SOW) and a summary of key considerations that have arisen in preparing this document and consulting with stakeholders.

Table 16: Illustrative components of toolkit and considerations

	Illustrative Component	Considerations
	Overall. The toolkit will be formatted as a combination of questions decision trees, checklists, options to choose from, or other formats to structure and ease options analysis and identification of trade-offs.	• The toolkit needs a starting point, and this should be in policy and legal framework, and the institutional responsibility. • The toolkit should be dynamic and user-friendly.
1	**Design and Complexity Checklist**. A design and options decision checklist will be provided that can be applied to every new potential investment in land information and transaction systems. The checklist could include system design features, sustainability drivers, a risk-and-mitigation assessment framework, and guidelines for "calculated risk taking" focused on the role of technology in solving the identified land-related problems. To the extent that such checklist tools already exist, opportunities should be sought to expand on or adapt these.	• Government often wants to buy the latest technology but has not considered process, objectives, or sustainability requirements. • Can be challenging to engage government to consider alternative options and providers. • Decisions can be made by technicians without significant buy-in at the higher-levels.
2	**Institutional Dimensions Checklist**. The toolkit should aid documentation and systematization of the extent of the types and levels of institutions that will be immediate or potential future beneficiaries of any land information and transaction systems investments. The goal is to help map out the relative complexity of an investment, necessary for consideration of areas of focus and risk. This includes identifying the national level institutions that would be system users and/or regional, local, and community level users as relevant.	• There should be alignment of incentives between people using, operating, and funding the system. • Government needs to be committed to using the system. • It would be worthwhile delineating responsibilities under different delivery models.

	Illustrative Component	Considerations
3	**Technology Dimensions Checklist**. The toolkit should define the parameters required to identify the level of technology currently used in relevant institutions, identify the level of technology that is most pertinent and least pertinent to the issue(s) needing resolution, and contain technical descriptions of the range of potential technology or systems options that address the issues and their distinguishing features. Decision trees or other tools could facilitate this assessment.	• The toolkit should enable choice of software development approach. • Need to consider alternative options and providers. • There should be careful investigation of available data. • The institutional checklist should include things such as the physical office building and services. • Standards should be listed in the TORs. • Need to manage the risk of change in requirements. • Need to manage the process of handing over an IT project.
4	**Financial Dimensions Checklist and Templates.** A standard resourcing method and template or workbook, should be developed to aid in ensuring that any system investments have sufficient budget levels for the risk/complexity they entail, and to ensure a common approach to system costing applies across a variety of investment opportunities and countries. Budgeting templates should be developed for costs, cost assumptions, and cost parameters, including oversight, and risk mitigation. The budgeting assumptions tools will be built after a review of budget templates used by MCC and other institutions. An easy-to-use total cost of ownership model should be developed to assist with analysis of technology options and costing of each option, drawing on other total cost of ownership models or frameworks that may already exist. Components that the template or workbook should address include: estimate of initial investment cost, annual operating cost, appropriate contingency percentages, other risk and mitigation costing, revenue, and explicit subsidy assumptions. The template/workbook would provide options to cost different management models, including long-term direct management by the partner government as well as management via a build/operate model. All costing-related tools should account for/acknowledge the data limitations in the environments in which MCC typically works.	• There should be clarity on financial management – government subsidy, what fees for what services are viable, estimated demand. • Consider the government fiscal environment and there should be fiscal modelling for revenue/expenses. • To the extent possible there should be upfront cost modelling and change management to lay the groundwork for long-term, systematic change. • Want to see alignment of incentives between people using, operating, and funding system.

	Illustrative Component	Considerations
5	**Sustainability Risk and Risk-Taking Analysis and Decision Tool**. Investing in land information and transaction technology systems in developing country contexts presents sustainability risks, similar to the sustainability risks of any other infrastructure investment that MCC might make. The tool should identify land administration IT risks. At the same time, all efforts to materially improve land administration involve taking calculated risks, so from this perspective the toolkit would also provide a framework for thinking about risks worth taking in the context of what is necessary to achieve the land sector objectives MCC is planning on achieving, and what mitigating resources are necessary to include in project budgeting.	• Government and the development partner should have a clear understanding on what sustainability is in the context of the project. • There should be clear understanding on ongoing licensing and other maintenance requirements. • There should be a common understanding and discussion on the larger issue of upgrading. • Is there a mechanism for the provider to stay connected post-project? • Government needs to have the capacity to manage and modify the project outcomes. • There should be engagement with the private sector and other agencies.
6	**System Design Parameters**. The toolkit may contain standard or typical design parameters or requirements, to which system investments would need to adhere to. Relevant questions would be: What would this look like? How could these concretely address/avoid the challenges faced? How specific and detailed would these design parameters be?	A useful guidance would be a detailed tool/checklist of things that need to be available prior to the decision to invest (decision tree/flow) covering the many different situations, and another one to deal with the elements that should be in place at start and during design and development processes: • project definition, • project approach (from design, development, deployment and operation years, maintenance/improvement), • IT system development method, • business processes and requirements, • strategy for legacy data and conversion, • project management, • steering committee, • institutional support and engagement, • beneficiaries' commitment, • funding and capital planning, • sufficient training/capacity building, resources, equipment, local specialists (IT, trainers, developers, etc.).

	Illustrative Component	Considerations
7	**Conditions**. This portion of the toolkit should map out investment conditions that MCC may consider applying to the funding or sequencing of land information and transaction systems. These would be conditions that the partner country would have to meet before MCC would make available funding for investments in land information and transaction systems or begin a subsequent activity. Are there "standard" conditions or criteria that if not met, would have MCC walk away from an IT investment? What are those conditions and criteria? When should they be triggered - at project design stage, or during project implementation, once approach/constraints are clearer? Or a combination? What are the risks/rewards of distinct conditional approaches?	• Need to ensure that there is high-level oversight. • There should be clarity on rights in digital data and who owns the system when the project cycle is over. • Can a fund be established to support the sector and help retain key staff? • Is there a requirement for the government to commit a budget for some number of years? • There should be agreement on the allocation of sufficient resources. Both withing partner agencies and within the compact project budget.
8	Other components as may be indicated by MCC.	

7.2 Conclusions

This final paper sets out a brief but substantive summary of the current state of practice, which has been revised in response to wide-ranging stakeholder consultation.

Key technology trends have been identified, with attention paid to those most relevant to LIC/LMIC contexts. Throughout, the document has emphasized the need for significant preparatory work prior to technology investment – including a government-wide (potentially long-term) commitment to e-Governance, business process reform, identifying local capacity needs, ensuring adequate budget is available and maintained, and ensuring supporting IT infrastructure is strong and secure.

This document sets out preliminary information for the Assessment and Design toolkit and provides the analytical foundation for the design and development of the toolkit.

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ANNEX 1 - Outline of Core Functional and Non-functional Requirements

This annex provides an outline of the core requirements for a land information and transaction system supporting an integrated land registry and cadastre. This outline could be used as a checklist to ascertain the scope and likely effort required to develop (or customize) a Land IT System. To prepare a comprehensive technical specification each of the listed requirements would need to be elaborated including the description of a test case for each requirement.

FUNCTIONAL REQUIREMENTS

Process Land Administration Transactions

- Case management
- Process services according to specific workflow logic including fee calculation & receipt recording
- Automated validation of workflow logic on-request and at critical workflow milestones

Manage Property Details

- Retrieve property details (including property history and associated supporting documents)

Manage Spatial Units (Parcels)

- Support subdivision/split of parcels service
- Support merge parcels service
- Support redefine/correct parcel service

Map Spatial information

- Search and view spatially defined cadastre objects
- Display other non-cadastre map layers

Manage Rights, Restrictions & Responsibilities (RRR)

- Support registration & recording of new RRR services
- Support cancellation of existing RRR service
- Support the recording of new RRR rights holders and any changes to details of rights holders for an RRR
- Bulk loading of RRR, rights holders and spatial cadastre objects when new systematic registration exercises have been finalized

Manage Digital Document Archive

- Scan documents supporting transactions
- Link scanned documents to service and appropriate property
- Search and retrieve land administration supporting documents
- Bulk importing of scanned historic documents

Reporting

- Generate land certificates
- Generate client search products (including cadastral map)
- Generate public notifications associated with services
- Auto generated email/SMS notifications to applicant/owner when key milestones of service are completed
- Generate progress report for a service
- Generate office (or staff member specific) transaction processing metrics report

NON-FUNCTIONAL REQUIREMENTS

System security

- User authentication
- User role management including managed access to perform certain functions and view certain database details
- Logging of all changes to critical data elements
- Auditing database changes and system access
- Firewall arrangements

Software Maintainability

- Maintain reference data / code lists
- Amend (business rule) logic of validation routines
- Support for refining language localizations (where relevant)

Software Portability

- Specify operating system
- Specify web browsers
- Specify means of deployment (desktop, local client-server, web client server, local server but “cloud ready”, cloud)

User Interface

- Style of user interface
- Dashboard
- Help function

ANNEX 2 – TCO Technology Deployment Costs

URL reference https://en.wikipedia.org/wiki/Total_cost_of_ownership

These generic costs will form the basis of a toolkit check list to identify costs that need to be adequately funded in a land information and transaction system for the ongoing sustainability of the system. Some of the listed costs will be excluded as they are not relevant to Land IT Systems but others, such as risk will need to be elaborated and widened to cover operational risk.

- Computer hardware and programs
  - Network hardware and software
  - Server hardware and software
  - Workstation hardware and software
  - Installation and integration of hardware and software
  - Purchasing research[56]
  - Warranties and licenses
  - License tracking/compliance[57]
  - Migration expenses
  - Risks: susceptibility to vulnerabilities, availability of upgrades, patches, and future licensing policies, etc.
- Operation expenses
  - Infrastructure (floor space)
  - Electricity (for related equipment, cooling, backup power)
  - Leased lines/private VPN[58]
  - Internet connectivity[59]
  - Testing costs
  - Downtime, outage, and failure expenses
  - Diminished performance (i.e. users having to wait, diminished money-making ability)
  - Security (including breaches, loss of reputation, recovery, and prevention)
  - Backup and recovery process
  - Technology/user training
  - Audit (internal and external)
  - Insurance[60]
  - Information technology personnel
  - Corporate management time
- Long-term expenses
  - Replacement
  - Future upgrade or scalability expenses
  - Decommissioning

[56] Not generally relevant to Land IT Systems

[57] Not generally relevant to Land IT Systems

[58] Addition to Wikipedia list

[59] Addition to Wikipedia list

[60] Not generally relevant to Land IT Systems