Feasibility Study for Establishment of
Land Data Infrastructure and
Land Information Service System in Sri Lanka

Final Report

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Korea Land and
Geospatial Informatix Corporation
Consortium

38 Eunhaeng-ro, Yeongdeungpo-gu, Seoul 150-996, Korea
Telephone: +82-2-3779-6114
Internet: www.koreaexim.go.kr / www.edcfkorea.go.kr

Acronyms & Abbreviations

Acronym/Abbreviation	Full Name
ADB	Asian Development Bank
ASYCUDA	Automated System for Customs Data
BIA	Bandaranaike International Airport
BMD	Birth Marriage & Death certificates
BOI	Board of Investment
CCTV	Closed Circuit Television
CDDA	Cosmetics Drugs Devices Authority
CEB	Ceylon Electricity Board
CINTEC	Computer and Information Technology Council
CIO	Chief Innovation Officer
CORS	Continuous Observation Reference Station
CPU	Central Processing Unit
CUSDEC	a Completed Customs Declaration
DB	Data Base
DBMS	Data Base Management System
DDoS	Distributed Denial of Service
DistSO	District Survey Office
DiviSO	Divisional Survey Office
DMZ	DeMilitarized Zone
DoLCG	Department of Land Commissioner General's(
DoRG	Department of Registrar General
DTI	Direct Trader Input
EAN	International Article Number System
ECEF	Earth-Centered Earth-Fixed
e-LG	e-Local Government
e-SLIMS	e-State Land Information Management System
EPZ	Export processing zone
ESM	Enterprise Security Management
FDI	Foreign Direct Investment
FMS	Facility Management System
FVP	Final Village Plans
FWLB	FireWall Load Balancing
GDP	Gross Domestic Product
GIC	Government Information Centre
GIDC	Government Internet Data Centre
GIS	Geographic Information System

Acronym/Abbreviation	Full Name
GNSS	Global Navigation Satellite System
GoSL	Government of Sri Lanka
GPNs	Global Production Networks
GPS	Global Positioning System
GSP	General System of Preference
IaaS	Infrastructure as a Service
KRAS	Korea Real estate Administration intelligence System
ICL	Import Control License
ICT	Information and Communications Technology
ICTA	Information and Communication Technology Agency
IDC	Internet Data Center
IFIU	Imported Food Inspection Unit
IPS	Intrusion Prevention System
IRD	Inland Revenue Department
ISM	Institute of Surveying and Mapping
IT	Information Technology
ITU	International Telecommunication Union
LAS	Land Administration System
LDO	Lands Development Ordinance
LGC	Lanka Government Cloud
LGII	Lanka Government Information Infrastructure
LGN	Lanka Government Network
LIS	Land Information System
LSD	Land Settlement Department
MC	Municipal Council
MCB	Main Circuit Breaker
MT	Metric Ton
MTDS	Medium-Term debt management strategy
MoLPR	Ministry of Land and Parliamentary Reforms
NARESA	Natural Resources, Energy and Science Authority
NBN	National Backbone Network
NBT	Nation Building Tax
NDC	National Data Center
NMRA	National Medicines Regulatory Authority
NMS	Network Management System
NOC	Network Operation Center
NSDI	National Spatial Data Infrastructure
NTT	Nippon Telegraph and Telephone Corporation
NVR	Network Video Recorder

Acronym/Abbreviation	Full Name
NVQ	National Vocational Qualifications
O&M	Operation and Maintenance
OECD	Organization for Economic Co-operation and Development
PaaS	Platform as a Service
PAN	Protected Area Network
PCP	Project Concept Paper
PIP	Public Investment Programme
PP	Preliminary Plans
PPP	Public-Private Partnership
PUE	Power Usage Effectiveness
RFID	Radio-Frequency Identification
Rs	Rupees
RTK	Real-Time Kinematic
SaaS	Software as a Service
SDSL	Survey Department in Sri Lanka
SLCORS net	Sri Lanka Continuously Operating Reference Station Network
SLECIC	Sri Lanka Export Credit Insurance Corporation
SLFP	Sri Lanka Freedom Party
SLPA	Sri Lanka Port Authority
SLD99	Sri Lanka Datum 1999
SLSDI	Sri Lanka Spatial Data Infrastructure
SLT	Sri Lanka Telecom
SMS	Server Management System
SOE	State-Owned Enterprise
SQL	Structured Query Language
SRIMS	Survey Requisition Information Management System
SW	Software
TCP	Traverse Control Point
TEU	Twenty-foot Equivalent container Unit
TFT	Task Force Team
TIN	Taxpayer Identification Number
TLDMS	Tenement List Data Management System
TM	Transverse Mercator
TopoPP	Topographical Survey Preliminary Plans
TRC	Telecommunication Regulatory Commission
TTA	Telecommunications Technology Association
UAV	Unmanned Aerial Vehicle
UN	United Nations
UNDP	United Nations Development Programme

Acronym/Abbreviation	Full Name
UNP	United National Party
UPC	Uniform Product Code
UPS	Uninterrupted Power Supply
USAID	United State Agency for International Development
UTP	Unshielded Twisted-Pair Wire
VAT	Value Added Tax
VM	Virtual Machine
VoIP	Voice over Internet Protocol
VP	Village Plans
VPN	Virtual Private Network
VRS	Virtual Reference Station
VTL	Virtual Tape Library
WAS	Web Application Server
WEF	World Economic Forum
WGS84	World Geodetic System 1984

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I. Project Overview

1. Background and Purpose of Project

1.1. Background of Project

❍ Modern land system of Sri Lanka was implemented during British Colonial Era(1796-1948) and it was implemented for the purpose of exploiting land and labor like other imperialcolonies.

– British government implemented the title registration to establish title plans system through surveying and established the survey department to begin production of survey plans.

❍ SDSL (Survey Department of Sri Lanka) is a government institution established in 1800(About 220 years of history) which is responsible for collection, production, processing and service of land and spatial information

– SDSL has an education center, nine province survey office, twenty-five district survey office, and eighty-four division survey office

– However, the facilities and equipment are very old, which making it difficult to secure the timely and accurate services of the land survey, and the efficiency of computerization work is low

❍ Government of Sri Lanka is making an effort to resolve various land related social issues such as 『informal settlement of land』 and 『unfairness in taxation』 occurring due to excessive amount of unsurveyed and unregistered lands

– It has been promoting the e-Sri Lanka policy since early 2000’s and it has selected improvement of land related administration work as one of the 30 tasks for improvement of government work and it is expecting improvement in national income level through improvement in land related administration work

– Land transactions are low because it is difficult to get accurate land-related information and uncertain of guarantee of land ownership.

❍ Government of Sri Lanka(GoSL) strives to promote public services in land-related work through the introduction of unified and standardized Land Information System

– By sharing land data among the government agencies and linking related systems, GoSL is planning to introduce an integrated E-government portal for Land Administration such as Korea’s E-government system

– Re-engineering Government pursues the effect of strengthening administration capacity, fiscal consolidation, and opportunity cost for the public, which is based on the transparency and revitalization of land transactions, representing the need for land administration system, land information sharing, and public service system.

1.2. Necessity of Project

❍ The computerization of land-related historical data, such as land use and registration, should be used to strengthen the utilization of existing data and to provide a foundation for objective land administration.

- Establishment of basic data for land registration and administrative work through computerization of Old Survey Plans
- In addition to computerization of Old Survey Plans, graphic cadaster is established based on land use thereby activating land registration for private lands and to achieve advanced land management administration.

❍ Land related spatial DB construction and land information system development must be preceded for land administration system innovation of the government of Sri Lanka.

- Land information is a basic information required to guarantee land ownership which is the foundation of national economy and social contract and it is a key factor to develop and manage land resources of the country efficiently.
- Reform and advanced the underdeveloped land administration by establishing an online system for land information acquisition, registration, management and update. Through this, land-related social problems such as illegal possession of land and unfairness of taxation are solved.

❍ In order to lay the foundation for economic development through land value based on transparent land transactions, land information sharing and public portal services should be provided.

- Sri Lanka is maintaining active foreign capital attraction policy and it is making an effort to vitalize the real estate market but its difficulty in quick and accurate acquisition of land information is an obstacle to its vitalization of real estate and land trade.
- The online renewal system and service system of land information reinforce the immediateness and reliability of land information, which can expand private land and establish comprehensive management, development and conservation policies of the land.
- The Sri Lankan government strengthens the macroeconomic framework with secondary economic activities through land value by enhancing transparency in land transactions to promote individual land ownership and land value.

❍ In 2019, the Sri Lankan government requested the Korean government to provide EDCF support for building land information systems in order to strengthen the capacity of land administration and promote public services of land information.

- The firm commitment to building the Sri Lanka land information system can be confirmed through the diversified efforts of the Sri Lankan government to proceed as soon as possible with the help of not only Korea but also the world’s advanced countries (US, etc.,).
- The establishment of Sri Lanka land information system with the help of developed countries should be carried out under the policy principle of "protecting the rights of Sri Lankan engineers and localizing related technologies." Therefore, it is necessary to support the Korean government's EDCF and launch the project as soon as possible.

1.3. Purpose of Project

❍ "Establishment of Sri Lanka Land Information System" to improve Re-engineering Government and achieve macroeconomic framework.

– Improvement of Re-engineering Government through the establishment of land administration system that covers the acquisition, registration, management, update and sharing of land information.

– In addition to stabilizing pre-emptive land administration through computerization of historical land history information and construction of land status information, revitalization of land registration and advancement of land registration business system.

– Establishment of land information sharing system for the efficiency of land administration work of government departments and local governments, and achieve macroeconomic framework by transparency of land transactions through public service portal.

❍ Intending innovative improvement of land administration through the establishment of land information system based on the Information Communication Technology(ICT)

– Government of Sri Lanka intends to establish land information system for efficient management, balanced development and use of land resources to improve land administration

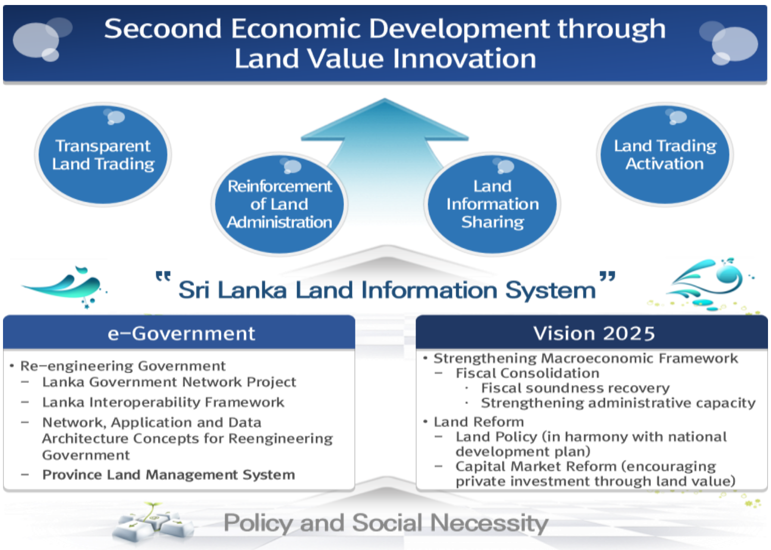
– Achieving reliable land administration by introducing ICT infrastructure for land administration online and land information service system.

– Land administration innovation through the combination of land-related soft infrastructure (human resources, organization, process) and ICT.

❍ Reinforce land administration competency of the government to reduce land related disputes and to protect the property rights of citizens(Rights related to land)

– Reinforce the government's capacity for land administration through the establishment of a land information system and provision of capacity building programs

– Reinforce the transparency and fairness of land administration through the establishment of a land information system to enhance the quality of land administration services to the public



[Figure I-1] Background and Purpose of Project

1.4. Scope of Project

- Project Period
  - The target project is the "Sri Lanka Land Information System Construction" project, which consists of consulting services, main project and operation maintenance support, which consists of 48 months of consulting service including supervision, 36 months of main project, and 24 months of operation maintenance support
- Project Contents
  - The scope of the project consists of six items: land and spatial information database construction, land information system development, data center and infrastructure construction, capacity building, operation and maintenance support, and consulting services.

[Table I-1] Details of the Project Contents (Final)

Project area			Description	Remarks
EDCF	Main Project (Construction)	Land and spatial information DB construction	Digital mapping: Computerization of Old Survey Plans Database setup (land, buildings & roads) Installation of GNSS CORS Network Utilization of satellite imagery	Target parcels: 3.50 million parcels Project areas: 24 major cities Installation quantity: 32 locations nationwide Imagery used: Ortho-images with 50 ㎝ resolution
		Land information system development	Establishment of a land administration system Establishment of a land information service system(geo-Portal) Entry of field notes and implementation field survey data processing and production of survey plan through system	Automation of land registration Land and spatial information service Field note inputted by SDSL
		Construction for Data center and infrastructure	Construction for Main data center Co –Location for Backup Data Center Improvement of work environment in Local Survey Offices Supplement equipment(PC) to twenty-four MCs	Survey Department 2nd floor National Data Center (SLT NDC) Twenty-five DistSO + Eighty-four DivSO Public Services
		Capacity Building	Training for fostering the professional instructor and expansion training for the operation and maintenance of the land information system in the future Invitation training for relevant authorities to Korea	The OJT will be held in Sri Lanka and will be subject to training and labor costs are covered by the Sri Lankan government.

Project area			Description	Remarks
			Conduct on the job training (OJT[1]) for 6 people field chosen by SDSL on system Development selected by SDSL. Improving the infrastructure environment of the ISM[2] training rooms	
	Operation and Maintenance Support		Operate and maintain per sector for two(2) years after completion of construction.	
	Consulting services		Basic design, supports the selection of the Contractor for main project(from preparation of request for proposal, assist in bid/proposal evaluation/contract negotiation between SDSL and the Contractor), supervision	
GoSL			Customs clearance, Taxes, operation and maintenance (organization, staffing, etc.) Operation of PMU(Project Management Unit) during project period(from consulting through completion of main project)	

1.5. Expected Effects for the Project

❍ Guarantee of land ownership through transparency and fairness of land administration system

❍ Rational and systematic decision support for efficient national territory development and economic revitalization

Land Tenure Security for the People

❍ Protecting citizens' property rights through land tenure security

– Prevention of social losses by resolving land-related disputes

❍ Increase public benefits by minimizing the procedure for solving land-related complaints

– Reduce transportation costs for citizens by reducing the number of civil service visits

– Reduce opportunity costs for civil complaints by reducing the time for handling civil complaints on land related issues

Improving Transparency and Reliability of Land Administration

❍ Increased confidence in land administration

1 On the Job training (OJT) : The training method of the personnel carried out through the job. In this feasibility study, six(6) people in the local service system are required to participate in the system development, testing and pilot operation for 36 months so that they can participate in their own operation and maintenance in the future

2 ISM (Institute of Surveying and Mapping)

- Disclosure of information on land information to the general public and fast processing based on the land information system

- ❍ Ensuring transparency of land registration and transactions
  - Increased land dissemination rate and improved living conditions for low income class

- ❍ Increase in productivity due to the efficiency of land survey Data capturing and processing
  - Reduce time for production of digital and softcopy of survey plan

Supporting the Decision-Making Process

- ❍ By integration of the land information channels of various government departments (Taxation, land registration, agriculture, forestry, environment, urban planning, housing, infrastructure, etc.) it can be reduced expenditures through the elimination of redundant tasks

- ❍ Systematic national land development planning
  - Provide basic data for establishing social overhead capital (SOC) and implementing a national infrastructure construction policy by providing information on parcel boundaries, land value, titles, various regulations / restrictions, etc. at the national level

Economic Vitalization from Land Ownership and Valuation

- ❍ Making it easy to access the land information and to facilitate the land use and land development, it is able to appraise the land valuation fair and rationally

- ❍ Improvement of reliability in land trade and vitalization of land trade and real estate investment which increases additional economic values of land

- ❍ Increasing in reliability towards land and spatial information regarding a particular project for the establishment of national Social Overhead Capital(SOC) can increase the foreign capital investment and lead to expectation of secondary economic growth

2. Project Implementation Area

- ❍ The project implementation area is divided into an implementation area for land and spatial Information DB construction, an implementation area for system development, an implementation area for data center and infrastructure construction, and an education and training area for capacity building.

2.1. Implementation area for Construction of Land and Spatial Information DB

- ❍ Since the primary target area for land and space DB construction is the nationwide of Sri Lanka, the entire Sri Lanka region is defined as the implementation area, and 24 municipal councils, which are the secondary target regions, are defined as the secondary implementation area.

1) Primary Implementation Area (Nationwide of Sri Lanka)

❍ 50cm Satellite Orthoimage Production

– 50cm satellite orthoimage is constructed for the nationwide of Sri Lanka, and ground control point surveys occur sporadically throughout Sri Lanka. Therefore, the nationwide of Sri Lanka is defined as the implementation area.

❍ Additional GNSS CORS Network Installation (32 locations)

– 32 additional GNSS stations have been installed throughout Sri Lanka, excluding Western Province. Therefore, the nationwide of Sri Lanka is defined as the implementation area.

❍ Computerization of Old Survey Plans

– The Old Survey Plans are kept at 25 District Survey Offices under the SDSL, and 25 District Survey Offices are distributed throughout Sir Lanka. Therefore, the nationwide of Sri Lanka is defined as the implementation area.

– Scanned Survey Plans of 25 District Survey Offices are as follows:

[Table I-2] Survey Plans scanned by District Survey Offices

Provinces	District Name	Total		Digitizing (2019. 05)	
		No of Plans	No of Lots	No of Plans	No of Lots
Western Province	KALUTARA	4,615	116,944	78	103
	COLOMBO	9,633	12,500	1,650	854
	GAMPAHA	2	0	1,744	1,002
North-Western Province	KURUNEGALA	8,820	349,060	4,327	213
	PUTTALAM	370	75,368	899	10,849
North Province	JAFFNA	2,856	30,246	385	1,996
	VAVUNIYA	416	52,687	411	6,700
	MANNAR	782	16,673	348	3,960
	MULATIVU	294	24,767	210	4,725
	KILINICHCHI	562	24,900	672	12,689
Central Province	KANDY	6,262	162,707	3,825	12,822
	MATALE	2,225	120,227	1,504	1,023
	NUWARAELIYA	2,759	70,356	317	30
North-Central Province	ANURADAPURA	2,212	514,464	1,759	2,893
	POLONNARUWA	689	253,492	467	6,805
Eastern Province	TRINCOMALEE	3,230	89,190	917	16,383
	BATTICALOA	2,797	12,098	512	1,420

Provinces	District Name	Total		Digitizing (2019. 05)	
		No of Plans	No of Lots	No of Plans	No of Lots
	AMPARA	4,081	171,434	1,890	9,910
Southern Province	GALLE	6,026	114,321	1,463	932
	MATARA	2,798	95,423	799	0
	HAMBANTOTA	724	188,862	0	1,037
SABARAGAMUWAI Province	KEGALLA	9,670	77,373	1,131	0
	RATNAPURA	1,116	388,887	275	0
UVA Province	BADULIA	458	176,814	408	963
	MONARAGALA	537	136,829	1,095	4,140
TOTAL		82,303	3,275,622	27,086	101,449

2)

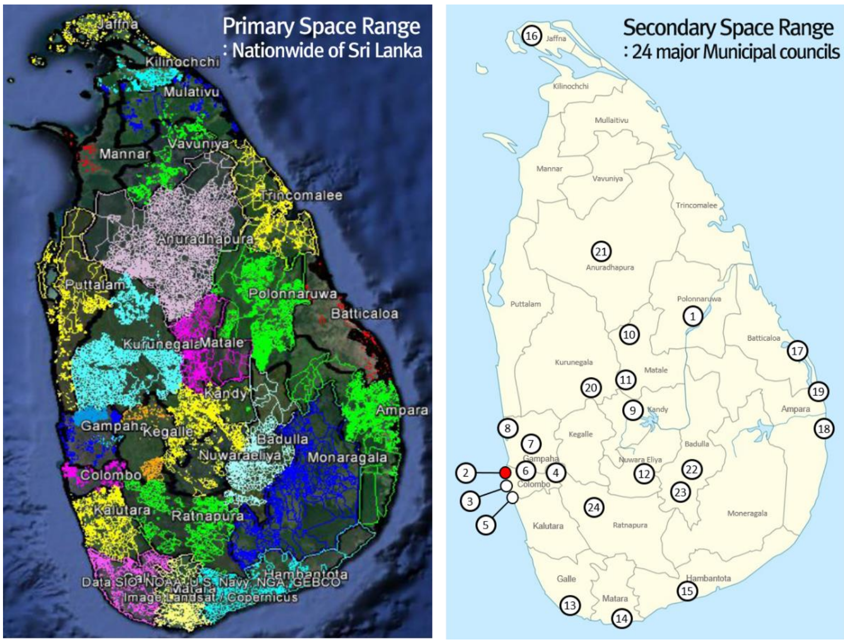
3) Secondary Implementation Area (24 Municipal Councils)

- ❍ Establish spatial DB of land, buildings and roads for local governments in charge of major administration based on land information for joint utilization and continuous renewal of land information.
- ❍ The major municipal councils are areas in which various license administrations frequently occur, and 24 MCs were selected through consultation with the SDSL TFT. The major MCs selected are as follows:

[Table I-3] Major Municipal Council Selection Results

District	Municipal Council	Area(㎢)
Colombo	Colombo	40.33
	Dehiwala-Mount	21.07
	Kaduwela	88.11
	Moratuwa	19.26
	Sri Jayawardanapura Kotte	16.47
Gampaha	Gampaha	27.81
	Negombo	28.53
Kurunegala	Kurunegala	11.80
Jaffna	Jaffna	19.49
Kandy	Kandy	27.01
Matale	Dambulla	57.05
	Matale	12.16
Nuwaraeliya	Nuwaraeliya	13.55
Anuradapura	Anuradapura	46.99

District	Municipal Council	Area(㎢)
Polonnaruwa	Polonnaruwa	38.14
Baticaloa	Baticaloa	38.10
Ampara	Akkaraipattu	5.39
	Kalmunai	28.53
Galle	Galle	18.70
Matara	Matara	21.02
Hambantota	Hambantota	82.78
Rathapura	Rathapura	26.37
Badulla	Badulla	10.61
	Bandarawela	8.75
Total		708.02



[Figure I-2] Implementation Area for Construction of Land and Spatial Information DB

2.2. Project Areas of System, Data Center and Infrastructure

❍ Project Areas of System, Data Center and Infrastructure are as follow

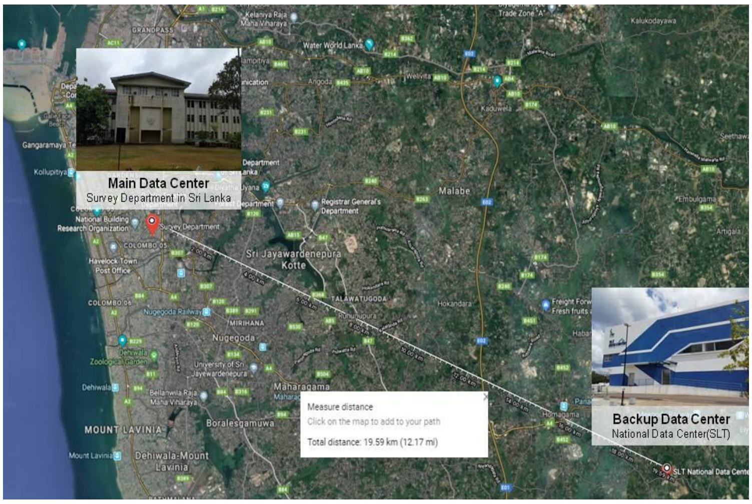
– One(1) Main Data Center and One(1) Backup Data Center

– Twenty Five(25) District Offices to improve the work environment

– Eighty Four(84) Divisional Offices to improve the network equipment

– 24MCs to be provided LAS User PC(including LAS Client Software)

❍ Main Data Center located No 150, Kirula Road, Narahenpita, Colombo 05 at SDSL 2nd and the Backup Data Center located Techno City, Pitipana, Homagama where is 20km far from SDSL the particular organization which is in charge of the operation and management.



[Figure I-3] The location map of Data Center

- Above mentioned local Survey offices and MCs are scattered throughout Sri Lanka, so that it is defined the entire region of Sri Lanka as a project area.

- And location of the relevant local survey offices are as follows

[Table I-4] Dist-SO and DivSO

Province	Dist-SO	Divisional Survey Office
Western	Colombo	Colombo, Kesbewa, Homagama
	Gampaha	Attanagalla-Bimsaviya, Gampaha, Ja-ela/ Wattala-Bimsaviya
	Kalutara	Kalutara - Bimsaviya, Mathugama, Horana, Pelawatta
North Western	Kurunegala	Kurunegala-Bimsaviya, Maho, Wariyapola, Galgamuwa, Nikaweratiya
	Puttalam	Anamaduwa, Madampe, Puttalam
Northern	Jaffna	Jaffna
	Kilinochchi	Kilinochchi, Kilinochchi 2
	Mullaattivu	Mullattivu, Mankulam
	Vavuniya	Vavuniya, Vavuniya 2
	Mannar	Mannar
Central	Kandy	Digana, Harispaththuwa-Bimsaviya, Kandy, Udunuwara- Bimsaviya (Doluwa), Yatinuwara, Minipe
	Matale	Dambulla, Matale, Laggala
	Nuwaraeliya	Kothmale, Nuwara-Eliya
North Central	Anuradapura	Anuradhapura, Kekirawa, Thambuththegama-Bimsaviya, Medawachchiya, Padaviya, Thirappane
	Polonnaruwa	Girithale, Hinguraggoda, Kaduruwela
Eastern	Baticaloa	Batticaloa, Vantharumoolai, Vellavelli
	Trincomalee	Kantale, Trincomalee
	Ampara	Akkaraipattu, Ampara, Mahaoya, Sammanthurai
Southern	Galle	Elpitiya, Galle, Udugama, Baddegama
	Matara	Akuressa, Matara, Kamburupitiya, Kotapola
	Hambantota	Angunakolapelessa, Hambanthota, Thissa-Bimsaviya, Weeraketiya
Sabaragamuwa	Rathapura	Embilipitiya, Kalawana, Pelmadulla, Rathnapura, Elapatha - > Rathnapura 2, Balangoda

Province	Dist-SO	Divisional Survey Office
	Kegalle	Kegalle, Ruwanwella, Galigamuwa
UVA	Badulla	Badulla, Bandarawela, Rideemaliyadda (Mahiyangana), Welimada
	Monaragala	Bibila, Monaragala, Galabedda, Thanamalvila

2.3. Implementation area for Capacity Building

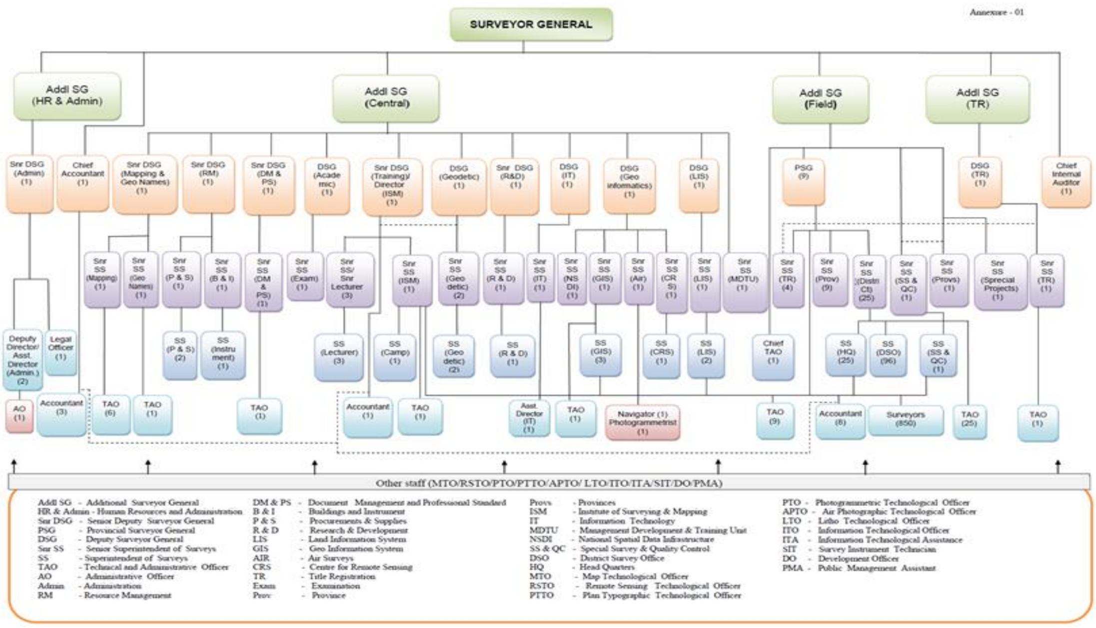
- Improving the educational environment is to improve the educational environment of the Institute of Surveying and Mapping (ISM), which defines Diyatalawa as the implementation area (Diyatalawa is located about 200 km east of Colombo, Sri Lanka.)

3. Institution for Project Execution

- The Institution of Project Execution is the Ministry of Land and Parliament Reform (MoLPR)
  - Major tasks of the MoLPR are the development and conservation of national territory, acquisition and management of national spatial information, land registration and management, and reform of the parliament
  - In this project, the MoLPR supports decision-making by the highest decision-making authority (as the umbrella of the SDSL), manages and supervises this project, and coordinates opinions of stakeholders and related ministries

3.1. Project Implementation Agency

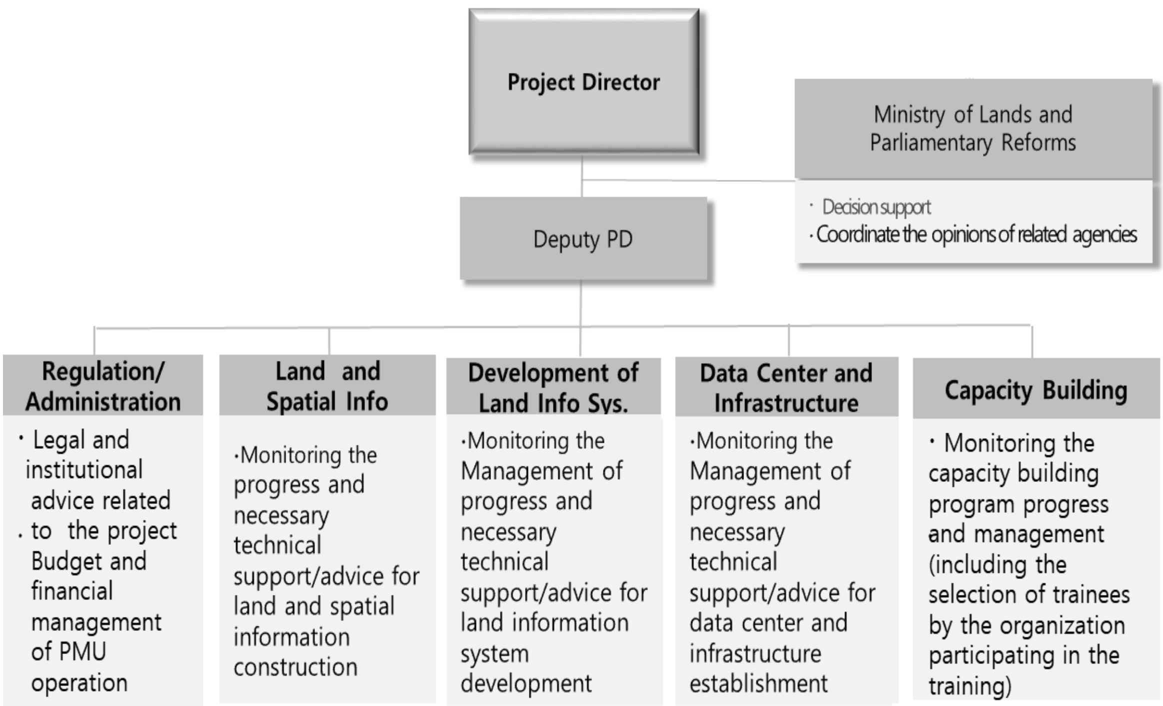
- Survey Department of Sri Lanka (SDSL) is the project implementer
  - The SDSL is an organization that oversees the acquisition and production of national spatial information, and produces/manages national territory information that involves measurement of the entire country, such as management of National Reference System, production of numerical maps and graphic cadaster, creation of satellite image maps, land survey, and establishment of land information systems



[Figure I-4] Organization Chart of Project Implementation Agency

- SDSL has 4 Additional Surveyor General and Director for Finance and Asst Director (Internal Audit) below the Surveyor General
  - Three(3) Addl-SGs operate and manage the fields of Human Resource Management and Administration, spatial information production and management, local office management
  - An Addl-SG(HRM) responsible for **Human Resource Management and Administration** is assisted by legal officer who is responsible for work related to competency reinforcement
  - An Addl-SG (Central), responsible for **the production and management of spatial information,** oversees geodetic, mapping and geonames branches, Geoinformatics Division including NSDI document management and Professional standard operations; Responsibility for tasks such as support of spatial information DB construction, construction of land information system, construction of data center and infrastructure and Monitor Financial Performance of the Budgetary allocation
  - An Addl-SG (Field), which is **in charge of managing local offices**, is responsible for field survey activities carried out by 25 District Survey Offices and the Monitor the Physical performance, nine(9) Province Survey Offices and twenty-five(25) District Survey Offices (Manage and oversee the District Offices and Division Offices); Working in charge of spatial information DB construction task
  - An Addl-SG(TR), **in charge of** the implementation of the Cadastral survey of Bim Saviya Program in relation to the Title Registration (TR) of land; Working in charge of building land information system

3.2. Project Management Unit (PMU)



[Figure I-5] Composition(Plan) of Project Management Unit

[Table I-5] Role and Responsibility of PMU

Category	Personnel	Role		Remarks
Project Director (PD)	1	Responsible for the overall project and manages the project progress.		
Deputy Project Director (DPD)	1	As the actual task manager, work order and progress are checked through real-time communication with the working group.		
Project Leader by sector	9	Legal and Institutional Support for Project and Administrative Management (1)	• One(1) person for project-related Legal/institutional support and PMU operation support (administration, budget, accounting, etc.)	
		Land and Spatial Information DB (3)	• Overall Technical Support of operation of land and spatial information • One(1) technical consultant for land and spatial DB establishment, one(1) technical advisor for UAV, one (1) technical advisor for DB deployment	
		Land Information System (2)	• Overall technical support in the field of system development and planning • Task analysis, design, development, verification, and system operation total of two(2) persons	
		Data center and Infrastructure (2)	• Overall technical support work in ICT infrastructure • One(1) person in charge of network & server, one(1) person in charge of information security facilities, one(1) person in charge of local network	
		Capacity Building (1)	• One(1) person in charge of selecting and managing relevant trainees in Korea and Sri Lanka and supporting the training program	

4. Project Schedule

❍ A total of 51 months' implementation schedule is divided into the following stages sequentially:,

– Selection of Consultant : 3 months

– Consultation (before main project): 12 months to prepare the selection of the Provider (Phase 1: basic design and bid preparation 7 months, Phase 2: support to proposal evaluation and contract support)

– Construction(by the Provider): 36 months (same as supervision period)

– Operation and maintenance is followed for 24 months after completion of the project.

[Table I-6] Detailed Schedule and Personnel Plan for Consulting Services(A)

Classification	Activities		Preparation of Consulting Service			Consulting Services																																															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
Selection of Consultant			■	■	■																																																
Consulting Services (48 months)	Phase 1	Site Survey and Basic Design				■	■	■	■	■																																											
		Preparation of bidding documents									■	■																																									
	Phase 2	Support to proposal evaluation and contract support											■	■	■	■	■																																		
Phase 3 Supervision (36months)																		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

[Table I-7] Detailed Schedule and Personnel Plan for Mai Project(B)

Classification	Activities		Month																																			
			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
Construction (36 months)	Establishment of Land and Spatial Information DB	Satellite imaging	■	■	■	■	■	■	■	■	■																											
		Computerization of old plan										■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
		CORS installation	■	■	■	■	■	■	■	■	■																											
		Building spatial database										■	■	■	■	■	■	■	■	■	■	■	■	■	■	■												
		Delivery of surveying and computer equip.	■	■	■	■	■	■	■																													
	Land Information System Development	Land administration system	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■												
		Land information service system													■	■	■	■	■	■	■	■	■	■	■	■												
		Integrated test																									■	■	■	■	■	■						
		Pilot operation and stabilization																															■	■	■	■	■	■
	Data Center and Infrastructure	Design of data center and purchasing equip		■	■	■	■												■	■																		
		Establish data center																					■	■	■			■	■	■								
		Functional and integrated test																								■					■	■	■					
		Stabilization of center system																																■	■	■	■	■
	Capacity Building	Invitation training in Korea									■							■																				
		OJT(field practice)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Training of fostering professional instructor																		■	■																	
		Expansion training for strengthening operator																						■	■													
		Improvement of training infra environment																■																				

[Table I-8] Detailed Schedule and Personnel Plan for O&M Support (C)

Classification	Activities	O&M Support																							
		52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Operation and Maintenance Support (24 months)	Intensive support of stable operation																								
	General support for stable operation																								
	Training support for reinforcement capacity building																								
	Operational indirect Support																								
	Remote operation support																								

❍ Selection of the Consultant (3 months)

– Estimated 3 months for bid to select the Consultant, proposal evaluation and contract agreement

❍ Consulting Services (12 months)

– The consulting services is largely divided into 2 stages; Phase 1 is to conduct site survey and basic design for 5 months and preparation of bidding documents for 2 months.

– Phase 2 is proposal evaluation support and contract negotiation support.

❍ Construction (36 months same as supervision period)

– Estimated 9 months for satellite imaging and CORS installation

- Conduct the old plan computerization and the establish spatial information after the delivery of surveying and computing equipment is completed
- Estimated 23 months for old plan computerization and 16 months for building spatial information
- Development of land information system
- Estimated 24 months for land administration system and 12 months for land information system
- Estimated 6 months for integrated test and 6 months for pilot operation and stabilization

– Data center and infrastructure

- Estimated 4 months for data center design and 15 months for procurement and fabrication of equipment, including 2 months for Integrated Factory Acceptance Test(IFAT)
- Estimated 3 months for environment improvement of district survey office and backup data center Construction, 3 months for main data center establishment
- Functional and integrated test will be carried out from M39 to M46 when the regional survey office environment improvement and backup data center is completed and M44 to M46 when the main data center construction is completed
- Stabilization for the center system during the last five months(M47 - M51) of the construction period, including the remote support during 2 months.

– Capacity building

- The two-week invitational training in Korea will be held twice.
- Trainings for fostering professional instructors, expanding trainings for reinforcement of local operators, and OJT for 2 months, 2 months and 36 months, respectively

- Improvement of the education infrastructure environment will be carried out for one month before local education (starting at M30)

❍ Operation and Maintenance Support (24months)

– Intensive support period for stabilizing operations for 6 months after completion of the project. In particular, local GIS engineers provide support until the end of operation and maintenance

– Operation stabilization general support period from 6 months after completion of the project. Specialized personnel in major business areas are deployed for 3 to 6 months(Data Center and infrastructure : shift operation)

– Providing additional and supplementary training once a half-year after completion of the project

– Indirect operational support and remote operation support are conducted by sector, but system development is carried out for 3 months and switched to remote support system for 12 months. Network, hardware, and information security for 6 months(Shift operation) and switched to remote support system for 6 months.

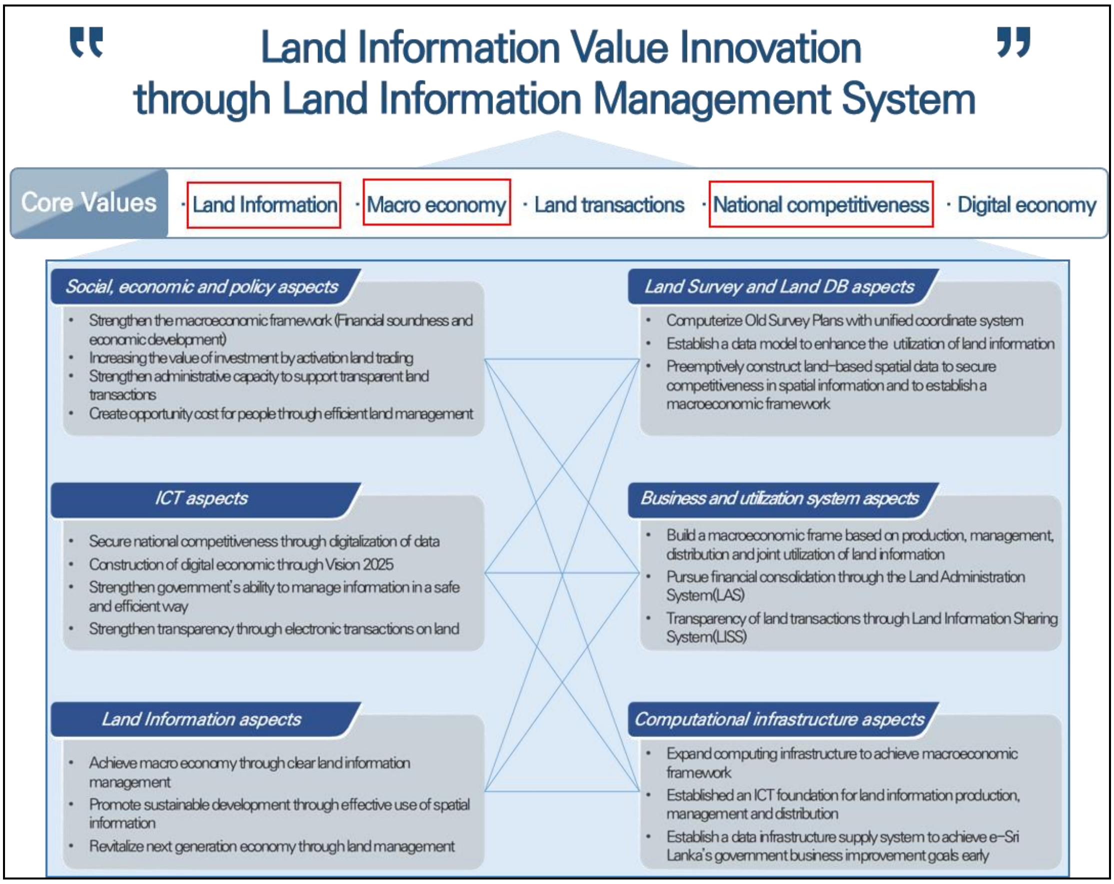
5. Project Execution Plan

5.1. Fundamental Direction

5.1.1. Future Vision of Land Information System

❍ Establish “Sri Lanka Land Information System Future Vision” by deriving core values through Sri Lanka's current status survey and target business analysis and combining key keywords.

❍ Future vision(plan) of Sri Lanka's land information system through various key words and core values deduced as “land information value innovation through land information management system”



[Figure I-6] Future Vision of Land Information System

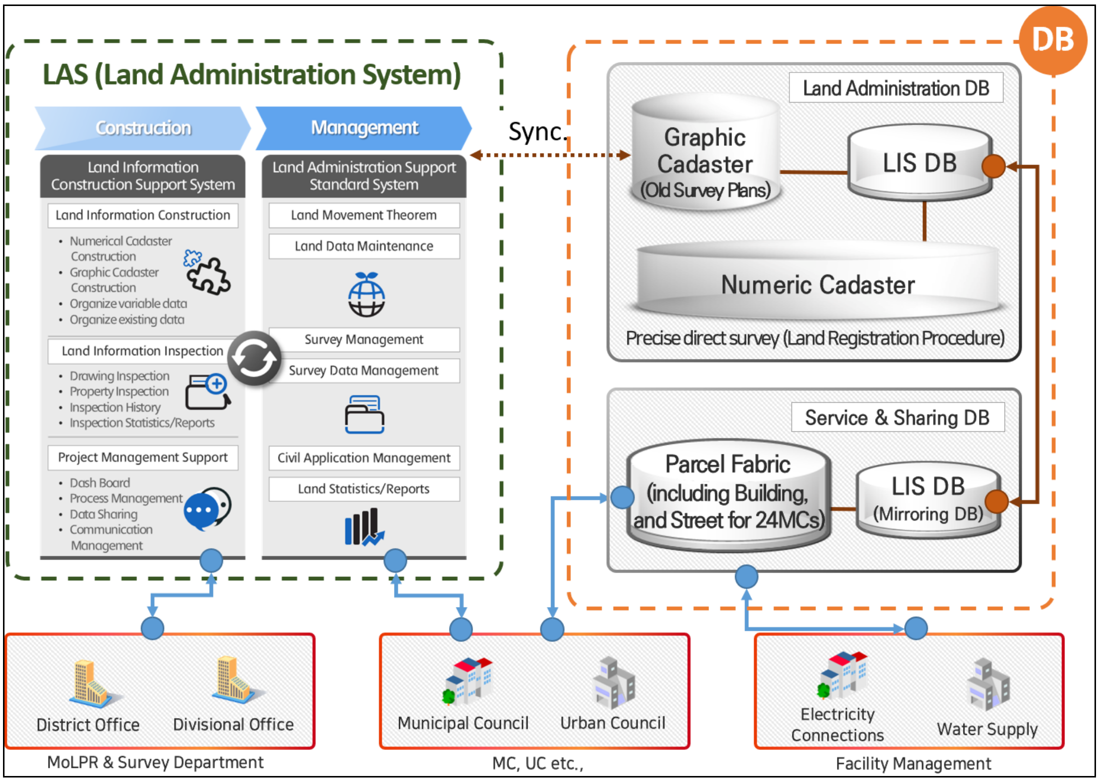
5.2. Target Model

- The land information system (LIS) of Sri Lanka is divided into two areas: 1) land information data part and 2) the system part for land information management and utilization.

- Data part consists of the land data obtained by digitizing the existing survey plans and spatial data on land, buildings, and streets from major municipal councils. This part also includes CORS Network installation and high-resolution satellite orthoimage production so that data can be built seamlessly.

- The system part consists of the systematizing the work processes in the land information production and management process, the administrative system that uses land information, and the land information service system that allows sharing of land information with related entities.

- The Target Model for the data and system parts of the LIS which is to be established through this project is as follows:



[Figure I-7] Target Model for Land Information System

❍ The target mode for the Sri Lanka Land Information System organic relationship between the data part and the system part, but also operating infrastructure to meet the requirements in relation to the data center and system functions for smooth system operation and services.

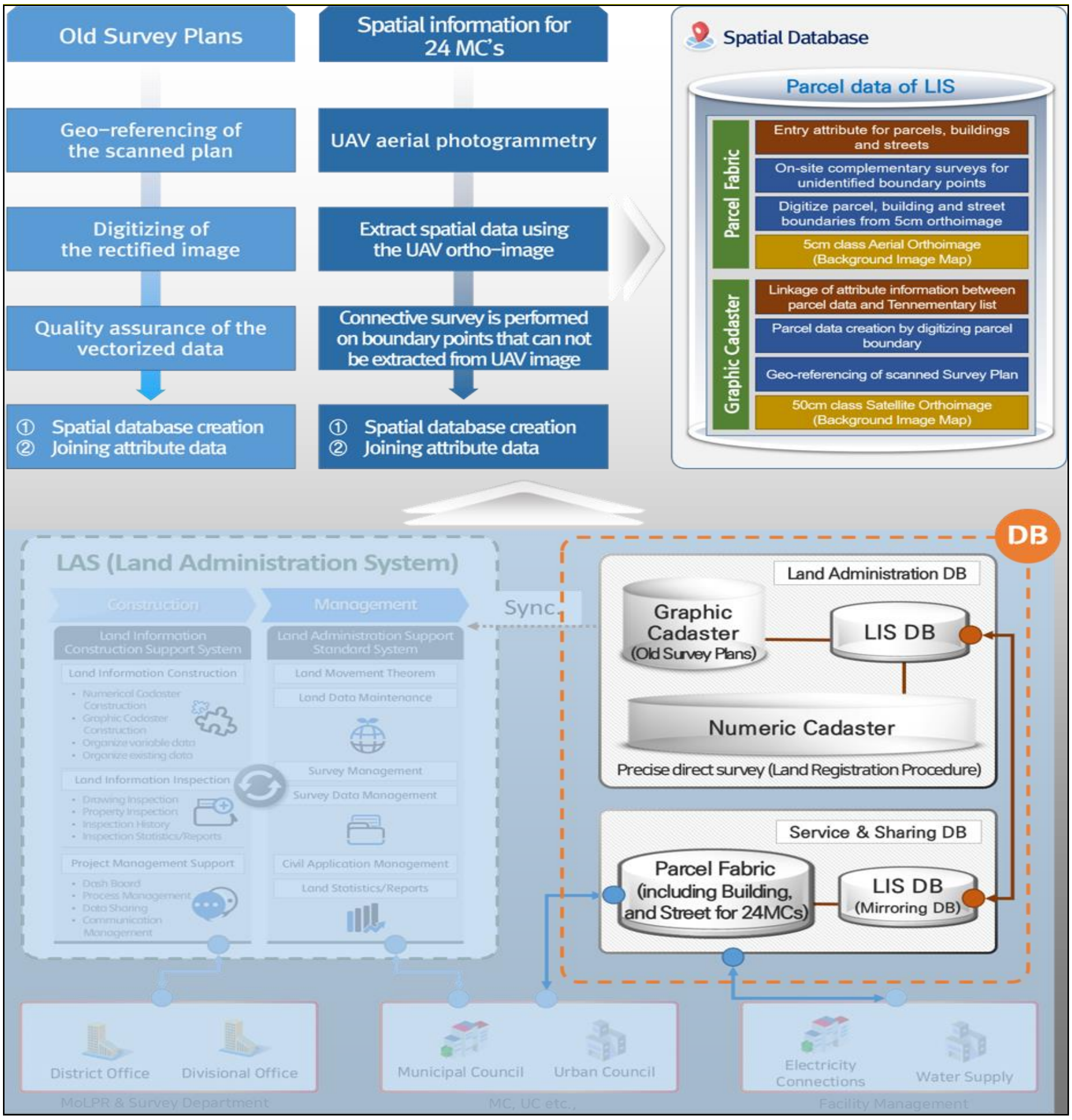
❍ Also, the system should be kept current by continuously updating data, and for this purpose, the necessary surveying and database construction infrastructure must be in place and the requirements for data construction, system operating organization, and the capacity of organization members must be met.

❍ Therefore, in order to achieve the To-Be Model for the Sri Lanka LIS, there must be a balance across the data area, the system area, the operating infrastructure area, and the capacity building of the operating organization and its members

[Figure I-8] Key Infrastructure for Land Information System

5.2.1.Target Model for Land and Spatial Information DB

- Land and Spatial Information DB section is updated as Numeric Cadaster[3] through land registration procedure based on direct survey.
  - Graphic Cadaster is extracted from old survey plans and 5cm UAV aerial orthoimages[4]
  - Numeric Cadaster is generated through field survey data



[Figure I-9] Target Model for Land and Spatial Information DB

3 Numeric Cadaster : Land information that sets land boundaries through precise direct surveying and confirming such performance

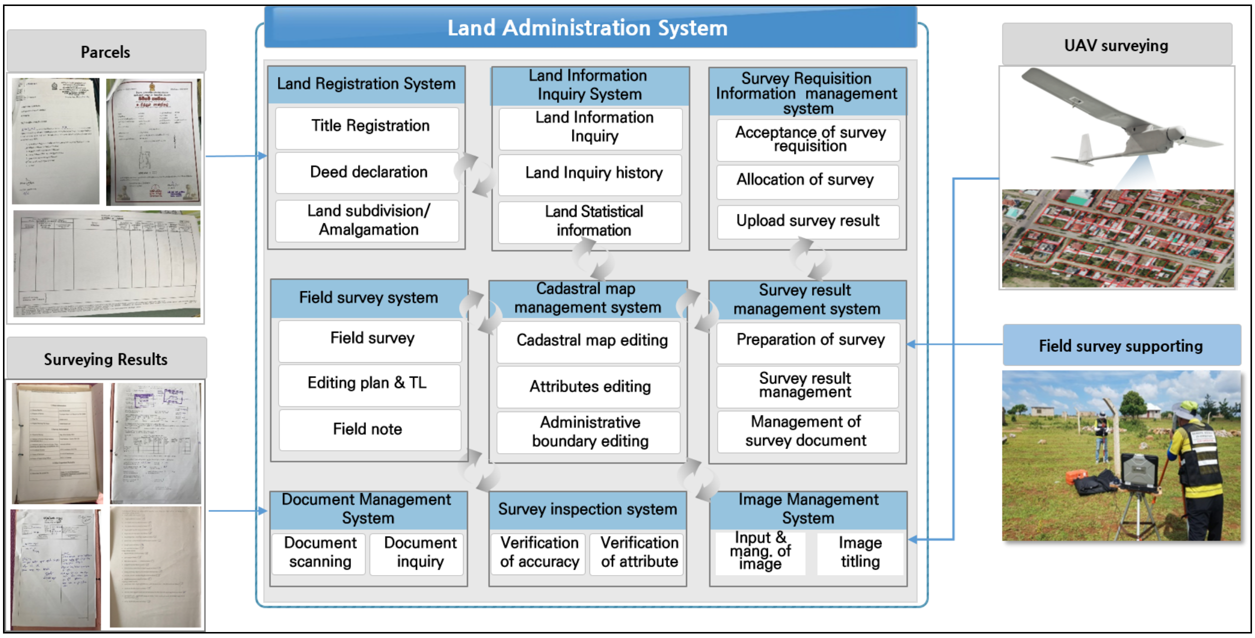
4 Orthoimage : Image that vertically projects and calibrates all points on the land through the process of orthoimage correction(Differential deviation correction) to remove displacement or distortion of the subject occurring at the time of satellite imaging

- To express the land information of Graphic Cadaster, building a database of image background map composed of 50cm satellite ortho-images and 5cm UAV aerial orthodontic image
  - The target model of database is largely composed of the background map section, the graphic cadaster section, Numeric Cadastre Section, the street and building space DB section, and the property information section of each land, building, and street.

- CORS-Network is established to enable Virtual Reference Station (VRS) services throughout Sri Lanka to maximize the efficiency of land surveying tasks.
  - 32 CORS-Networks shall be constructed in areas excluding the Western Province

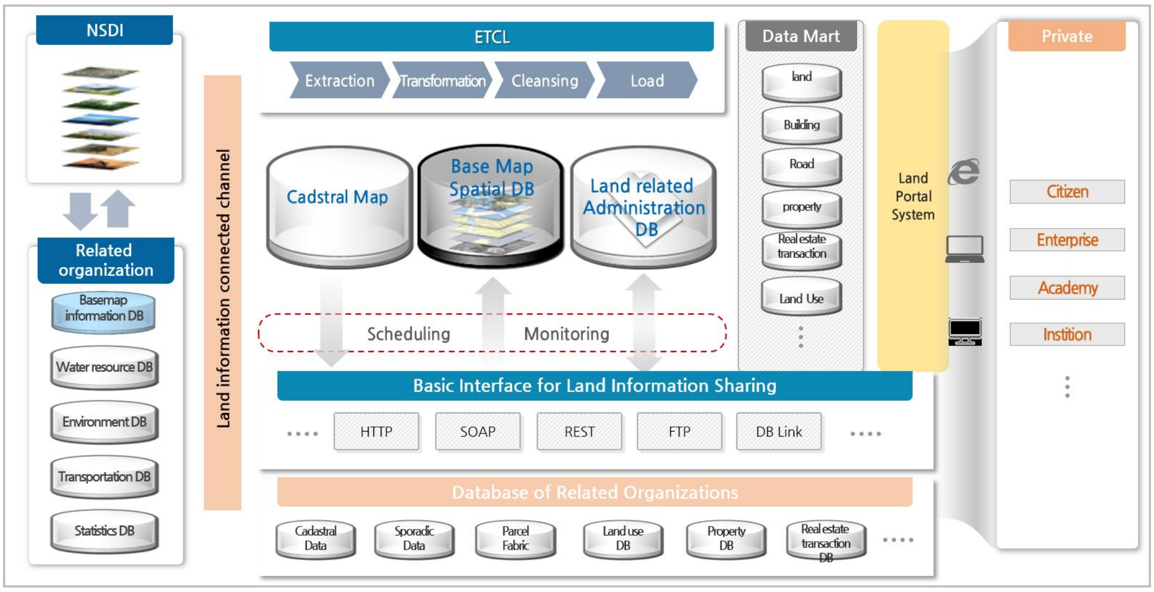
5.2.2. Target Model for Land Information System

- Land Administration System
  - Modularize land administration procedure and framework by key tasks and functions and develop it as a central system for integrate operation
  - Develop to allow direct update, search, or revise data acquired from existing map or books, or data acquisition on site



[Figure I-9] Target Model for Land Administration System

- Land Information Service System
  - Establish service system to allow citizens to conveniently access the land information of state land or private land through internet along with cadastral map provided with satellite image and aerial image
  - Easily access and check the progress status of private civil-services anywhere anytime through the internet



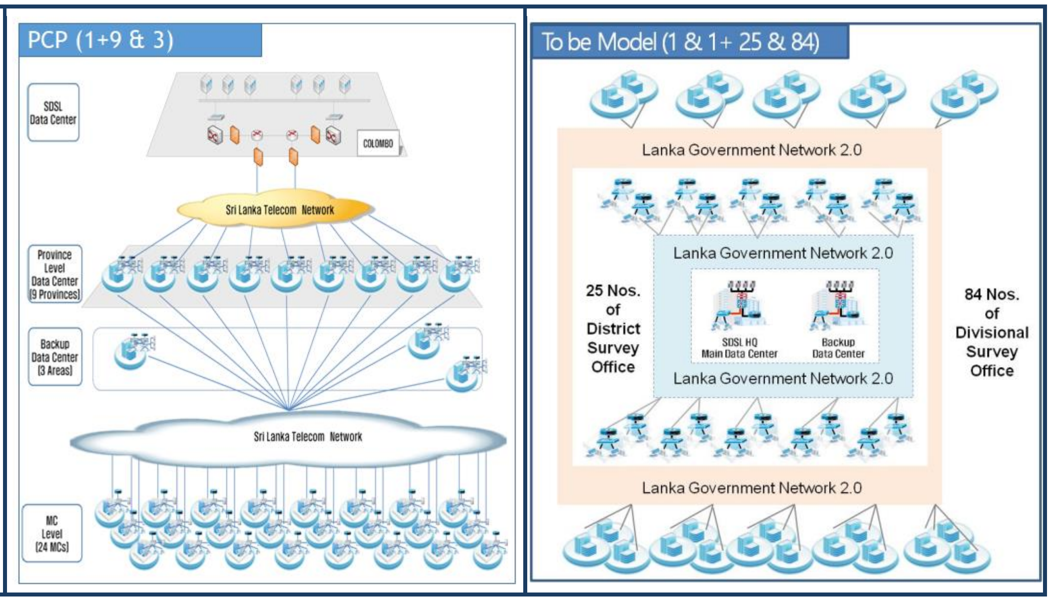
[Figure I-10] Target Model for Land Information Service System

5.2.3. Target Model for Data Center and Infrastructure

❍ Construction of Main Data Center / Backup Data Center

– Operate Hot site(Same composition, real-time synchronization) between Data Centers

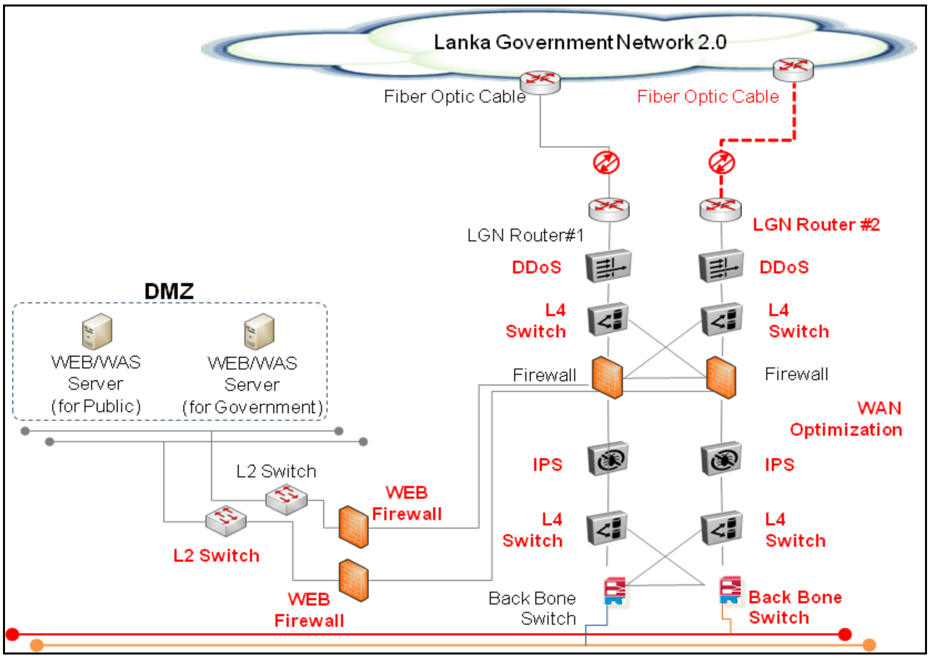
[Figure Ⅰ-13 PCP vs Target Model Comparison] Composition Map Comparison



[Figure I-11] PCP vs Target Model Comparison

❍ Data Center Network Construction Plan

– Redundant Network and expanding of bandwidth



[Figure I-12] Data Center Network Construction Plan

5.3. Implementation Plans

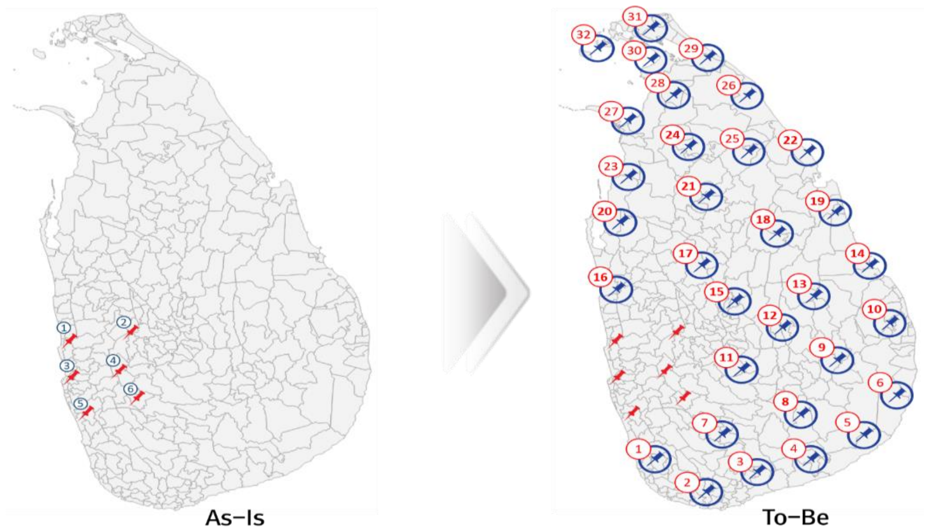
5.3.1. Implementation Plans for Land and Spatial Information DB

1) Overview

- Installation of Additional GNSS CORS Network (hereinafter referred to as "GNSS CORS Station") throughout the nationwide of Sri Lanka
- Produce and supply high resolution (50cm class) satellite orthoimages in unified coordinate system (SLD99).
- Computerization of Old Survey Plans based on satellite orthoimages (create spatial data for each parcel).
- UAV surveys are conducted for 24 municipal councils.
  - Produce aerial orthoimages(5cm GSD) and Construction of spatial DB for parcels, buildings and streets based on aerial orthoimages.

2) Installation of Additional GNSS CORS Station

- Additional installation of 32 GNSS CORS stations throughout the nationwide of Sri Lanka
  - Consist of 38 stations total including 6 GNSS CORS stations in the Western Province.
- The additional GNSS stations will be set up so that a triangulation network among nearby stations.
  - The baseline distance that constitutes the triangle network is not to exceed 100km, and the islands in the southern and northern parts of Sri Lanka are also configured not to exceed 60km so that VRS services can be performed smoothly.



[Figure I-13] CORS-Network As-Is & To-Be

3) 50cm Satellite Orthoimage Production

- ❍ Establish high resolution satellite orthoimages for the whole of Sri Lanka.
  - – Use as background map of national basic map and national spatial information system.
  - – Use as key data of graphic cadaster for construction of land information.

- ❍ KOMPSAT-3 is a high-resolution earth observation satellite equipped with an electro-optical camera with a resolution of 70cm that became the cornerstone of Korean commercial satellite imagery. In March 2015, KOMPSAT-3A equipped with a mid-infrared sensor and a precision optical sensor was launched, and it is currently providing images comparable to those provided by commercial satellites.

- ❍ With KOMPSAT-3/3A, satellite imaging across Sri Lanka is expected to take about eight months, including new and complementary shots. This is a valid supply period to use as a base image for Sri Lanka land information construction.

- ❍ The new satellite image supply plan proposed by Korea Aerospace Research Institute, a multi-purpose satellite operator, is as follows.

- ❍ Satellite orthoimages production for the whole of Sri Lanka shall be based on new shooting images by KOMPSAT-3/3A satellite.
  - – Utilize mono-scope images and 1m grid digital elevation model[5](DEM) to perform ortho rectification procedure.
  - – Digital elevation model for the entire territory of Sri Lanka shall be 1m grid spacing and be within the tolerance of vertical accuracy is under 3m

5 Digital Elevation Model(DEM) : Refers to numerical model that expresses the topography excluding buildings, trees, and artificial structures within real-world topographic informatio

[Table I-9] KOMPSAT-3/3A Image Proposal

Image service	Standard
Coverage method	Monscopic
Application theme	Mapping and Land Management
Image mode	Strip
Product type	Bundle
File Format	GeoTiff
Preprocessing level	1R(1A)
Viewing angle	W30° ~ E30°
Clouds + Shadows	10%
Snow + Ice	10%

KOMPSAT-3,3A BLUE Standard Imaging Proposal

From : KARI

To : SI Imaging services
SATRECI ref. : SIIS-NTO-5390-LX-2019_NS002-Sri Lanka

This proposal must be confirmed before : ASAP
If you do not confirm this proposal by the date indicated, your NTO will be automatically cancelled.

Chances of success

With initial parameters : Low
With proposed parameters : High

Notes

We have performed a feasibility study of your imaging request with the initial parameters:

Kompsat-3,3A satellite will be used for this request, in order to acquire 336 bundle images (i.e. 672 products), in order to cover your AOI.

It appears that the chances of success would be Low, due to climatic conditions and programming conflicts.

In order to maximize the chances of success, we suggest you to extend the survey period until 08/01/2020.

Proposed Imaging parameters

Imaging service : standard   Coverage method : Monoscopic

Application theme : Mapping and Land Management

Production specifications:
Product type : Bundle
File Format : GEOTIFF
Preprocessing level: 1R(1A)
Delivery support: FTP

Image mode : Strip

Survey method : single period

Period : 1: Initial parameters start : 28/05/2019 end : 31/07/2019
Proposed parameters start : 28/05/2019 end : 08/01/2020

Viewing angle : between W30° and E30°

Location of survey zone : AOI (Area Of Interest) imported from shape file

Validation criteria (Percentage on the AOI) :

Clouds + shadows : 10%   Snow + Ice : 10%
Others : Haze is not accepted

[Figure I-14] Satellite Ortho-images Production Process

❍ Due to the marine climate of Sri Lanka, if the cloud is more than 10% of the newly recorded KOMPSAT-3/3A satellite image, re-shooting is performed. Complementary use of commercial satellite imagery (Airbus's Pleiades-1A/1B or Digital Global's GeoEye-1) prepares a complementary measures for acquiring new images.

❍ In the case of mountainous areas with little change in terrain, KOMPSAT-3/3A satellite images acquired before the project can be used. It decides the final use through the verification and verification process of the acquired image together with the Survey Department.

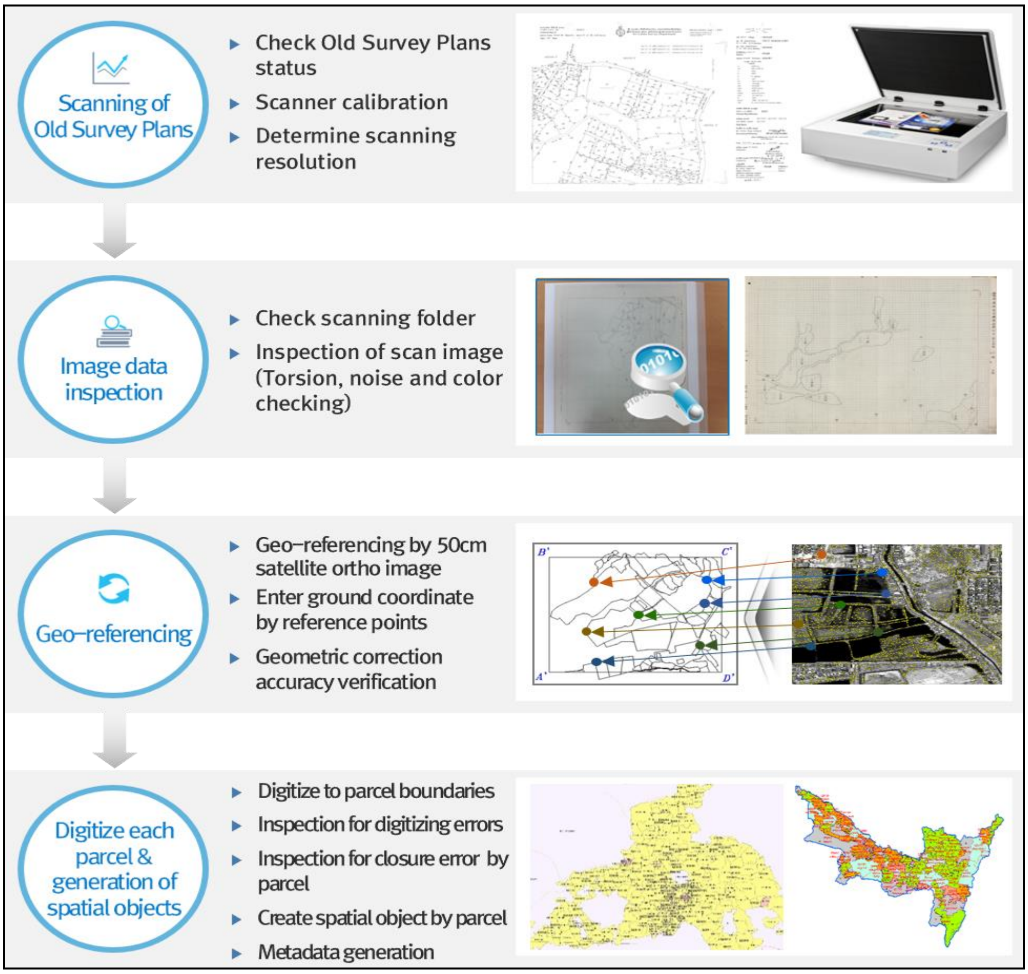
4) Computerization of Old Survey Plans

❍ Target Volume for Computerization of Old Survey Plans is 82,303 sheets which have been scanned already

– But, they must be diagnosed so that they can be classified according to their condition (scanning quality) and low-quality ones must be re-scanned.

❍ The scanned survey plans are divided into high-quality, normal-quality, and low-quality. Low-quality must be re-scanned.

– The estimated amount of Low-quality scanned plans is about 10% of the total amount.

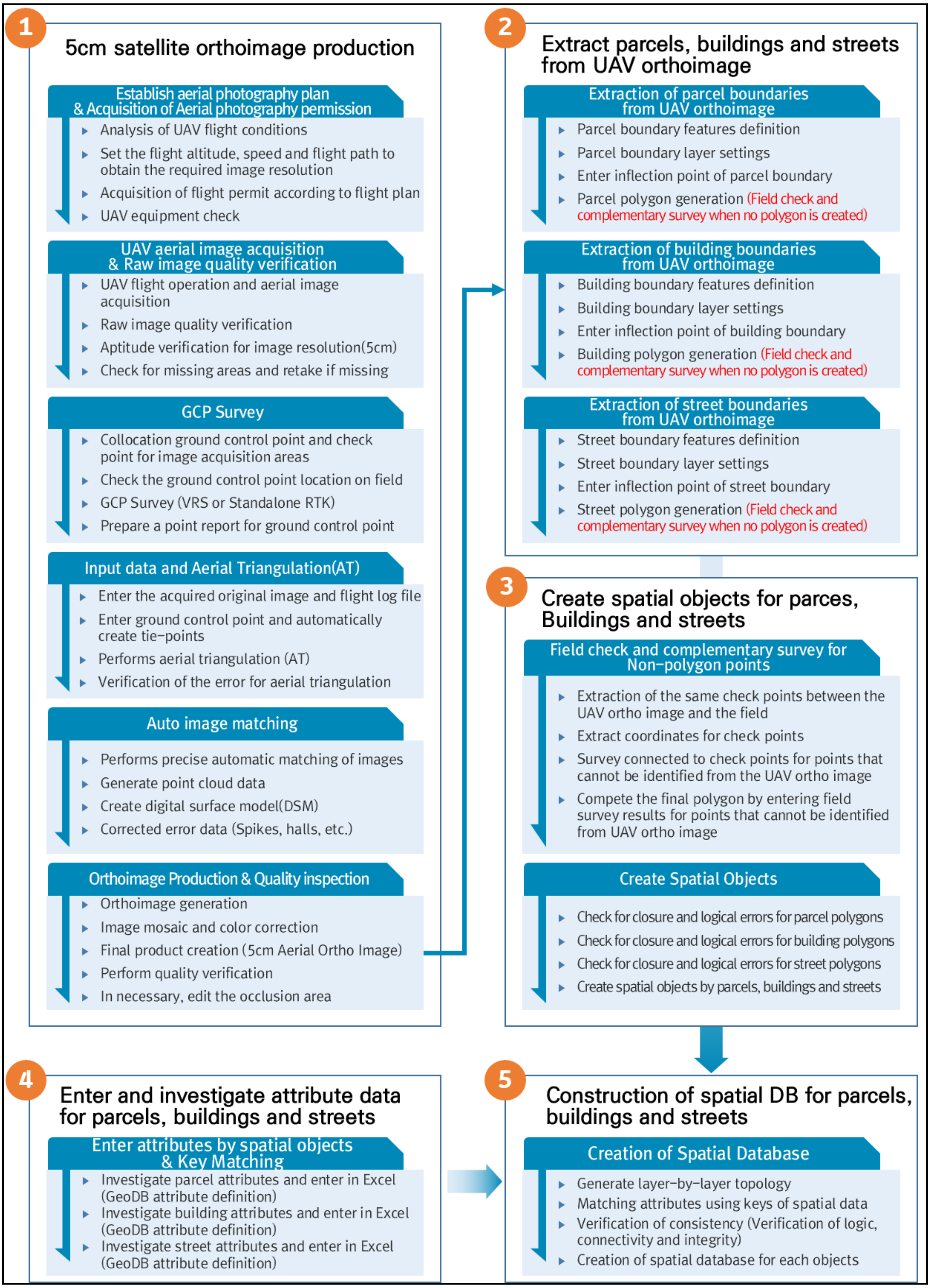


[Figure I-15] Computerization Process of Old Survey Plans

- The coordinates of the ground points as the reference points can be checked on the scanned survey plans and the coordinates of the ground points shall be extracted from the 50cm satellite ortho-images
  - The coordinates of the ground points for at least six reference points should be entered for each survey plans
- Geo-referencing of the scanned survey plans should be carried out through a 2D affine transformation using the coordinates of the ground points of the reference points.
  - The accuracy of the geo-referencing should be verified by analysis of the residual and root mean square error of the reference point coordinates after the 2D affine transformation.

5) Land and Spatial DB Construction for 24 Major MCs

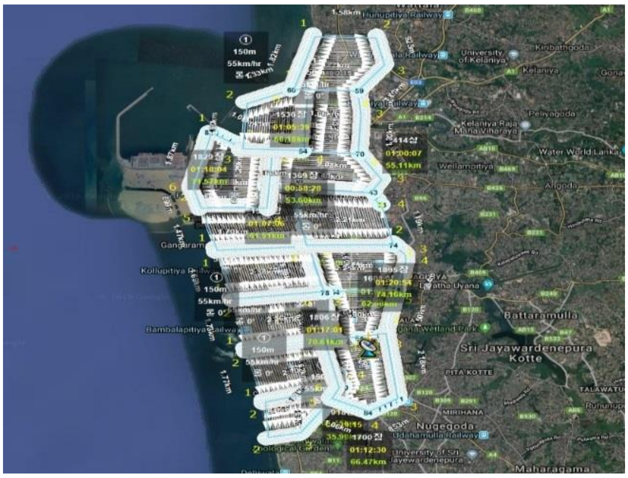
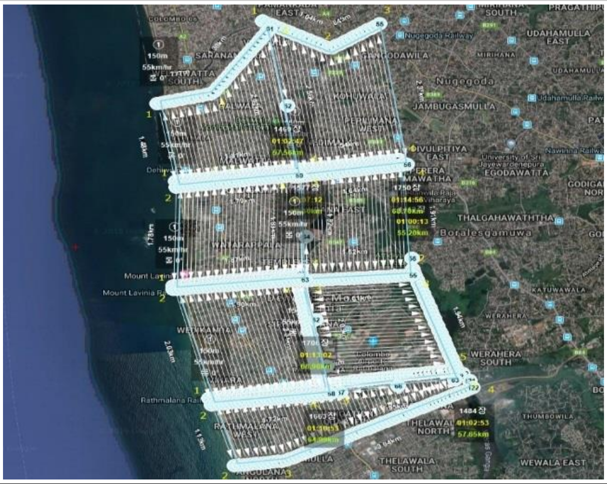
- The land and spatial database for the parcels, buildings, and streets of 24 major municipal councils (MCs) will be established based on spatial data extracted from 5cm aerial orthoimages by UAV survey.



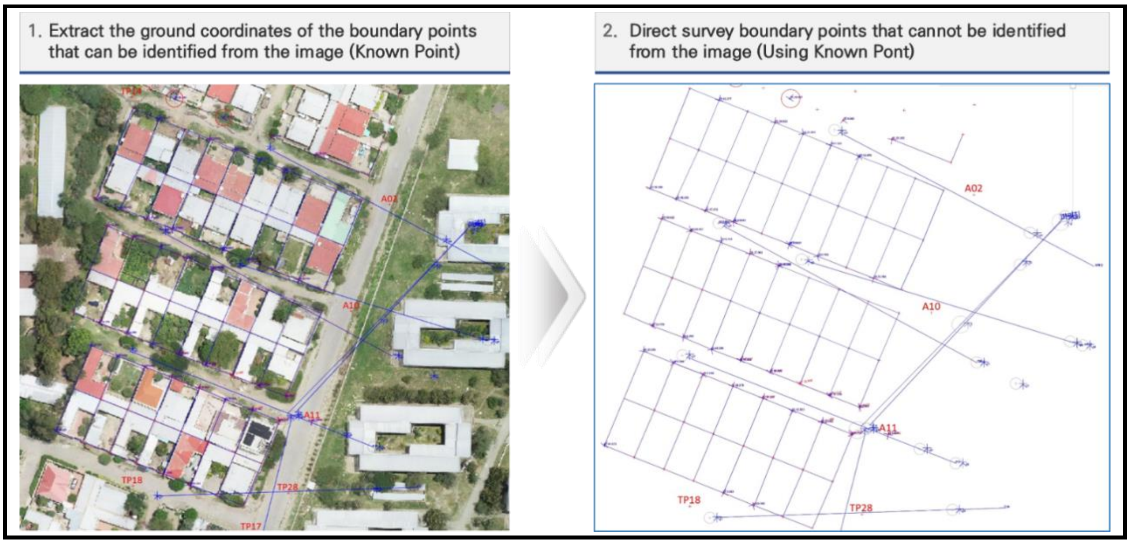
[Figure I-16] Spatial DB Construction Process for 24 Major MCs

- ❍ Data acquisition plans for aerial ortho-images(5cm GSD) production using UAV
  - – Preparation of the flight plan for data acquisition plans using fixed wing UAV.
  - – Flight altitude 150m / Flight speed 55km/h / End-overlap 75% / Side-overlap 65%

[Table I-10] Flight Plan for 24 Major Municipal Councils (Sample)

Colombo Municipal Council	Dehiwala-Mount Municipal Council
	

- ❍ Utilize screen digitizing method for extracting boundaries of parcels, buildings, and streets.
  - – Apply boundary feature layer defined by digital data management regulations of SDSL
  - – When boundaries of parcels, buildings, and streets cannot be identified due to obstacles such as trees in the aerial orthoimages (5cm GSD), identify as not-confirmed points and renew through on-site complementary survey.



[Figure I-17] On-Site Complementary Survey for Non-Confirmed Points from aerial orthoimages

- ❍ The coordinates of the ground points of not-confirmed points are acquired through on-site complementary survey, and the coordinates are connected with the confirmed points identified via the orthoimages so as to create spatial objects in the form of polygons for parcels, buildings and streets.

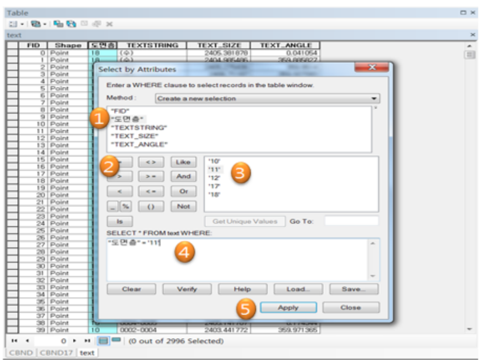
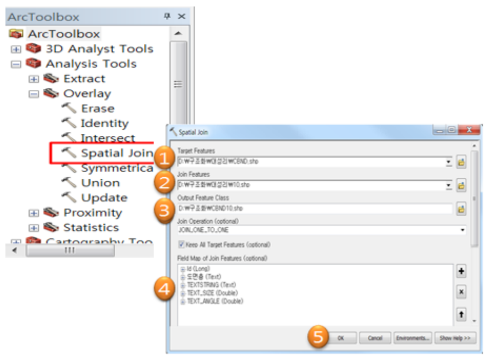
– In this project, if the boundary point cannot be identified in the 5cm class aerial orthodox image, it is set to about 20% of the total boundary point (this is based on the results of the 2017 LX pilot project).

– On-site complementary survey of non-confirmed point is conducted by traverse survey using Total Station, and provides on-site survey support system (including pen-computer and on-site survey support SW) for this purpose.

– Parcel boundaries were extracted through 10cm UAV aerial ortho-images over pilot application area consisting of urban and rural areas of Sri Lanka and over 70% of parcel boundaries were identifiable through this imaging according to the results of existing project (pilot project)

❍ For each spatial object for parcels, buildings and streets, the results are determined by checking the spatial data such as inspection of continuity and integrity of parcels the logical inspection of the buildings and streets.

– Construct attributes for spatial objects such as parcels, buildings, and streets according to data model re-defined through this project.

Select by Attributes	Spatial Join
	
1. Select layer 2. Select operation '=' (equal) 3. Select '11' (ex, Land Use) 4. Express the selected condition 5. Apply	1. Select the objects to join (ex, parcels) 2. Select attribute data item 3. Input SHP filename to save 4. Delete unnecessary fields 5. OK

[Figure I-18] Structured Editing

❍ The cadastral data model and sporadic data model defined by the SDSL are used as the data models.

– The LIS data model including the unique numbers of parcels (parcel ID, asset number and Asset Street) are used.

❍ As the attribute classification for attribute inspection, attributes are classified into common attribute elements included in all parcels, buildings and streets and independent attribute elements included only in the spatial objects of parcels, buildings and streets.

6) Provision of Equipment of Survey and DB Construction

❍ Utilize for construction of land and spatial DB for Sri Lanka LIS operation.

– Categorized as computer equipment and survey equipment

- Survey equipment
  - UAV Survey : SDSL
    - UAV Survey Equipment : 5sets
    - UAV Data processing S/W : 10copies
    - UAV Data processing H/W(Workstation) : 10sets
  - GNSS Survey Equipment : SDSL and District Survey Offices
    - District Survey Office : Each 1set (total 25sets)
    - SDSL : 3sets (Reserve)
  - Total Station Survey Equipment : SDSL and District Survey Offices
    - District Survey Office : Each 1set (total 25sets)
    - SDSL : 3sets (Reserve)
  - On-Site Survey Support System (including Pen-Computer and S/W) : SDSL and District Survey Offices
    - District Survey Office : Each 1set (total 25sets)
    - SDSL : 3set (Reserve)

- Computer equipment
  - PC : Computerization of Old Survey Plans and Construct spatial DB from aerial orthoimages
    - District Survey Office : Each 5sets (total 125sets)
  - Workstation : Consists of equipment to consistently manage/renew constructed data
    - District Survey Office : Each 1set (total 25sets)

5.3.2. Land Information System Development Plans

1) Goal for System Development

- Establishment of land administration system that includes functions of land registration, survey result management, field note management and linkage with land assessment information of local authority

- Establishment of land information service system that allows the citizens to conveniently check information of cadastral plan, roads, and buildings through the Internet

- Establishment of management system to create cadastral survey results by UAV and T / S and manage survey history

- Establishment of system that can manage high resolution UAV orthoimages and overlap them with cadastral map

- Establishment of linkage system that can link and utilize cadastral plan with various related organizations such as DoRG, LSD, DoLCG, SDSL, and MC

2) Plan for System Development

- ❍ Implement a system that improves work productivity by improving waiting and delays by introducing information sharing systems among related organizations in land-related work

- ❍ Inquiry of the latest land information and visualization of various statistical information such as tables and thematic maps so that they can be reasonably utilized for decision-making of land policy.

[Table I-11] Improvement for task performance by land-related organization

Category	AS-IS	TO-BE
SDSL	• Delays caused by collective updates of cadastral maps within cadaster areas by SDSL • Poor surveying productivity due to a lack of a system for surveying data acquisition, results preparation, and results inspection • Provide only cadastral maps that do not include buildings and streets • Visual inspection of most of the survey results	• Eliminate delays by distributing cadastral map updates across regions using the system • Improve surveying accuracy and productivity by introducing field surveying support system (TOSS) and surveying results preparation and inspection system • Bolster the prestige a cadastral and spatial information agency by providing multi-purpose cadastral maps that contain information on buildings, streets, and land use
DoRG	• Currently, it often takes more than 50 seconds to check a parcel map via LSD, attesting to the inefficiency of the public services • There is no system for online delivery to LSD when a title certificate is produced for the first time	• Improvement of service quality for citizen by Improving public services by boosting the parcel map checking speed with a better system server and network • Speed up processing speed by sharing information online with related organizations such as LSD, SDSL
LSD	• Inefficient because cadastral maps in Bim Saviya are provided offline • Lack of delivery system for sharing information with relevant entities at various stages of the Bim Saviya program	• Boost work efficiency by receiving cadastral maps online via the LAS • Increase productivity by reducing waiting time through the sharing of information on the progress of each step of the Bim Saviya program in real time
DoLCG	• Lack of a practical system for selecting targets for land alienation	• Transparent selection of beneficiaries of land alienation through the system
MC	• In the case of land sub-division, final approval is by MC, and information is not automatically reflected on the cadastral plan. • The assessment number is not entered in the cadastral map, so the land valuation information of the parcel cannot be linked	• After land sub-division approval, the system automatically reflects the cadastral plan to always use the latest cadastral plan for work. • Land valuation information can be used in the system by inputting the assessment number managed by MC

3) Plan for System Development

- System development methodology is to develop a system by applying agile methodology that is widely used in large-scale remote system development.

- System is developed in cooperation with local private companies to secure the foundation for maintenance and foster private experts in the future and their roles are analysis of business, analysis of needs, function design, development of GUI, function for simple query of information, unit test, integrated test, pilot operation and so on.

- System is developed in three languages which are Sinhala, Tamil and English. Main contractor is developed in English and local developer is developed in Sinhala and Tamil version in the system

- The GIS engine required for system development is based on open source, and the DBMS engine uses Oracle (including SDO components), the most commercial DBMS used for spatial information.

- Prevents security risks and increases user convenience by applying a Single Sign On (SSO) service that allows access to multiple systems with only one account without having to go through the authentication process for each system.

- Investigation and analysis for system development are carried out locally within 4 months after the start of the project, and system development is carried out in collaboration with the contractor and the surveyor's OJT staff.

- The development period is two years, and the next one year, unit test, integrated test, pilot operation, and system installation are carried out. Especially, the system self-operation capability is enhanced through technology transfer, capacity building for user and operator

4) Scope of System Development

- System development of each phase of this project consists of sub-systems so that the necessary functions for each module can be used by each institution, and the contents of development are as follows.

[Table I-12] scope of development of land information system

Category	Sub-system	Overview
Land Administration System	Land Registration	It is a system that registers title of land, receives and registers the owner information about land, and complaints such as land sub-division, amalgamation, etc., and can check the existence of parcels in connection with spatial data and issuing certificates for citizen
	Cadastral Map Management	This is system to Imports cadastral survey data to generate a topology, and then generates parcels, and parcel sub-division, Amalgamation parcels, modifies parcel boundaries, and manages features such as cadastral maps and administrative boundaries. Plays the role of the base system to check the existence of parcels in the land registration system and function to export 'shape' file
	Land Information Inquiry	It is a system that inquires registered cadastral information and inquires past history data so that uses it for various administrative tasks. It also consists of functions that express various subjects for easy and convenient use by connecting cadastral statistics information by

Category	Sub-system	Overview
		administrative area with spatial data
	Survey Requisition Information Management	It is a function to accept survey requests by complaints and agencies, and then assign surveying tasks to survey technicians, manage the priority of survey requests, assign surveyors, and upload survey data
	Survey Result management	A system for preparing cadastral survey results by UAV and T / S, which includes functions for survey calculation, result storage, drawing and record, and linking function to register the cadastral survey results with cadastral map management system
	Survey Inspection system	This system checks the result of cadastral surveying by UAV and T / S. It consists of the function of attribute verification, file verification, attribute error, feature verification, overlap checking and printing out survey result map
	Field Survey	Field survey supporting system that applies new technology to acquire cadastral data more easily and quickly in the field, consisting of functions such as real-time observation results, superimposition of image data, and creation of survey results
	Document Management	A system that scans documents and field note that are submitted with survey results, inputs meta information, and uploads them to a server. This allows users to quickly search scanned documents along with cadastral maps. The document management system can also be used to scan and store documents submitted by the complainant in land registration
	Image Base map Management	The image base map management system integrates satellite image, aerial and drone image by region and shooting date. It creates image index and meta information so that the user can conveniently search for the desired image. Allows to check the video screen in 2 or 4 divisions to analyze the image in time series
Land Information Service System		For citizens to overlap with satellite images and aerial photographs, the service will be established so that land information such as cadastral maps, state-owned lands, and private lands can be conveniently checked through the Internet and easily check-up application status through the internet

5.3.3. Construction Plan for Data Center and Infrastructure

1) Selection of Project Area

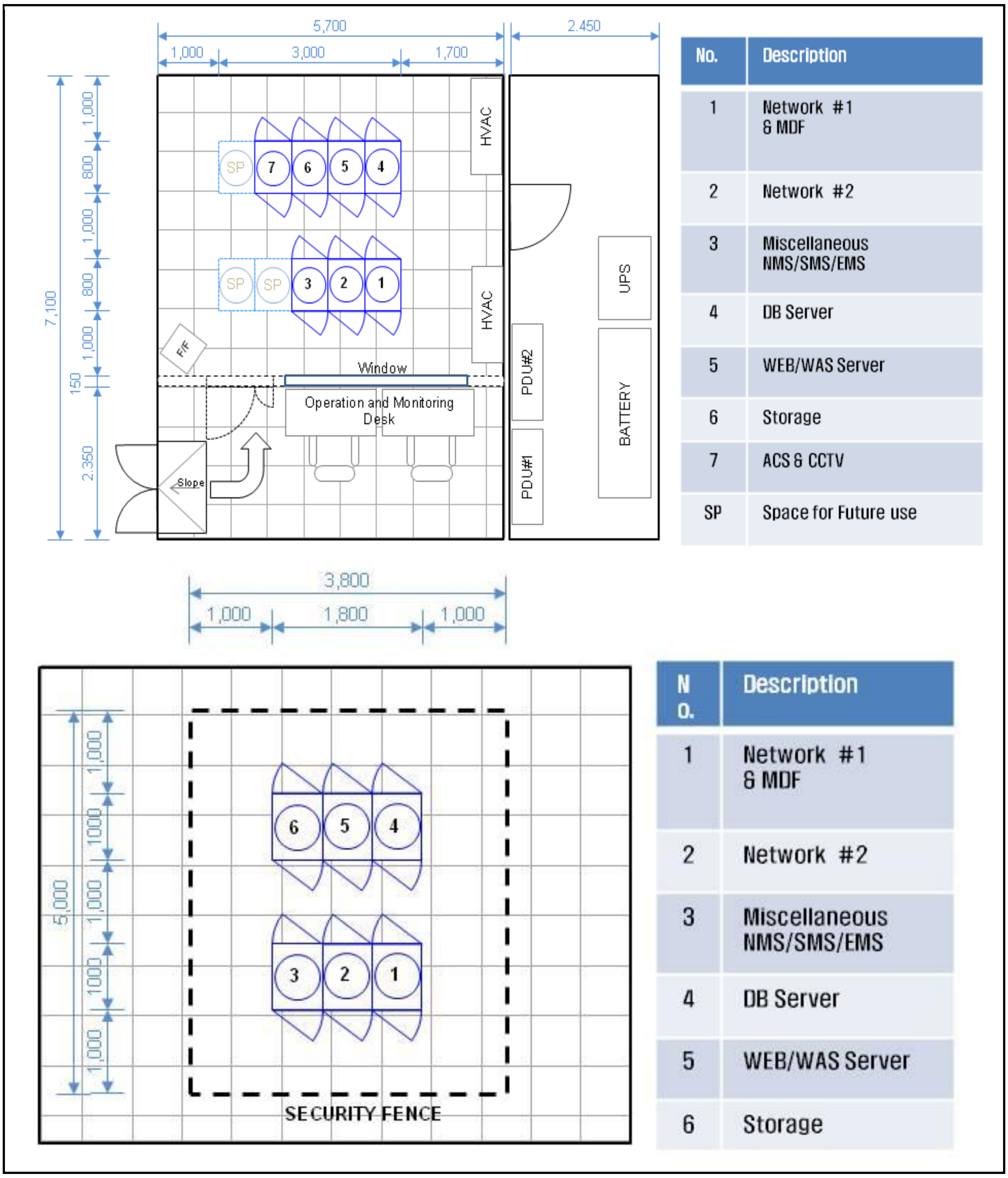
- ❍ Headquarters office of SDSL(Survey Department of Sri Lanka) under the Ministry of Lands and Parliamentary Reforms.

- ❍ Second(2nd) floor of SDSL headquarters is the space where main equipment, network link and operating personnel for existing LIS(Land Information System) are located

2) Space utilization Plan for Data Center

- ❍ Utilize the space on beside of existing server room(Currently work space for O&M personnel)
  - – As for the installation of rack, two (2) layered array is possible and space for 3 racks for future expansion can be secured

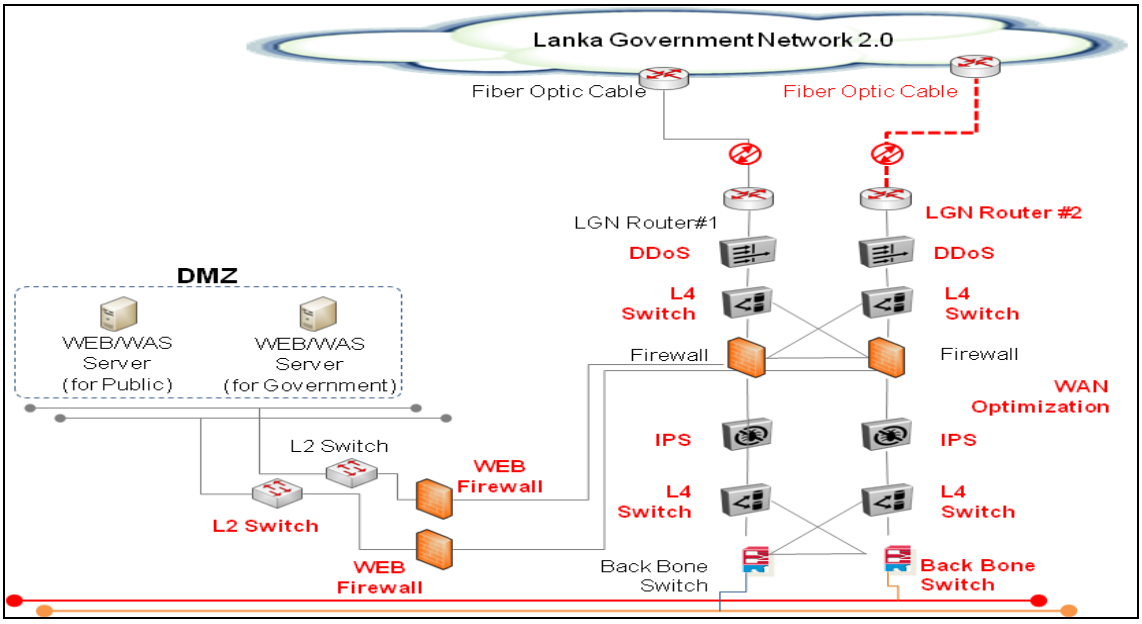
- ❍ Utilize the space in NDC(National Data Center) for Backup Data Center



[Figure I-19] Utilization Plan for the Spaces in the Data Center

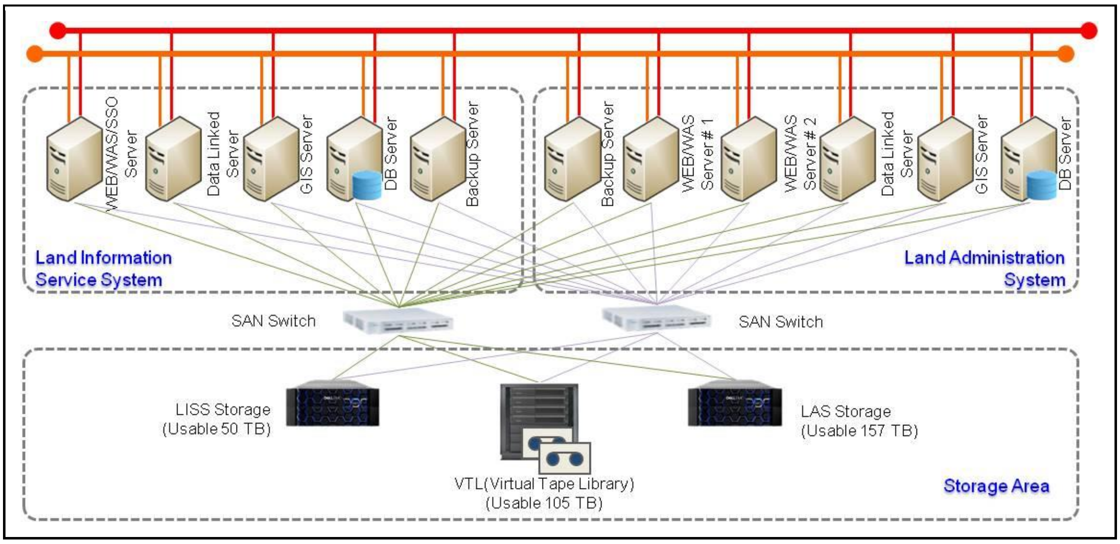
3) Construction Plan for Hardware/Software/Network

- ❍ The Sri Lanka Land information System network is designed using the LGN 2.0 network to connect the main Data Center and the local survey office in consideration of stability, flexibility, security and expansibility.



[Figure I-20] Construction Plan for Data Center Network

❍ Storage Design Concept: Service data area should physically separate the LAS(Land Administration System) and LISS(Land Information Service System)

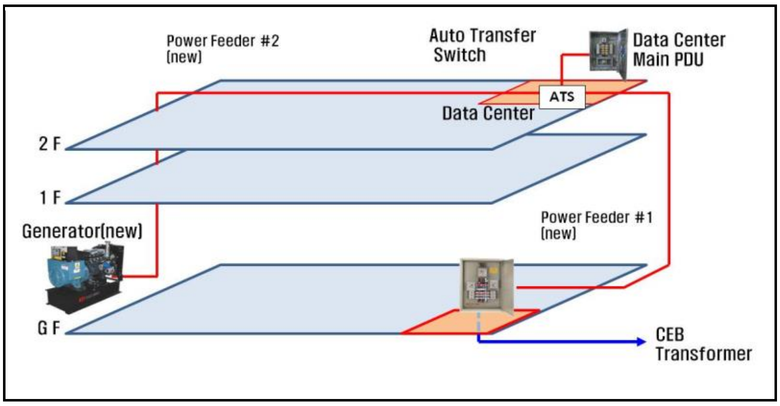


[Figure I-21] Storage Area Composition Plan

4) Environment Facilities in Main Data Center

❍ Power system : To supply constant power and emergency power through Generator (with Installation of 50 KVA UPS[6])

6 UPS : Uninterruptible Power Suppl



[Figure I-22] Power Facility Diagram

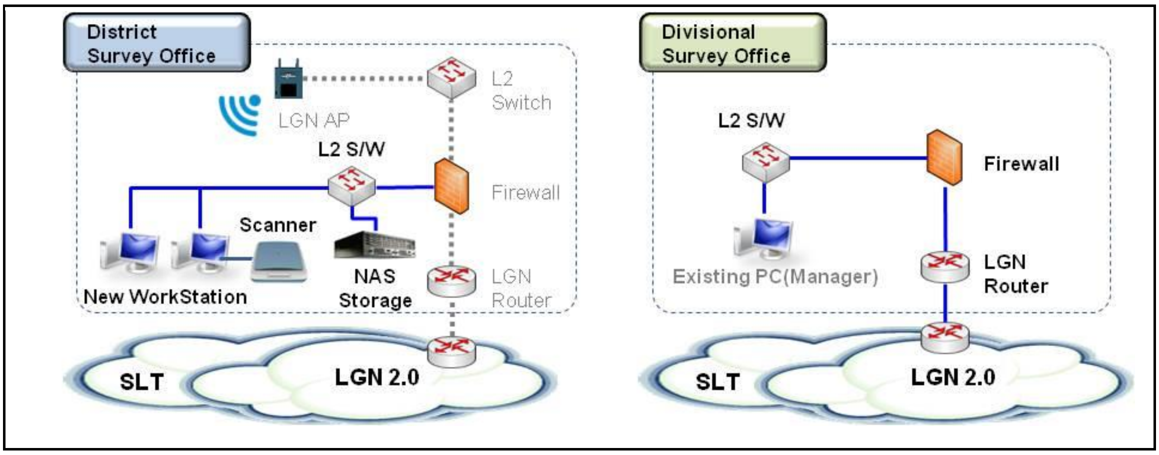
- ❍ Thermo-Hygrostat: To maintain certain temperature and humidity, in order to prevent infrastructure system disruption and improve system utility and reliability
- ❍ Fire Suppression: To install Fire Suppression system(NOVEC 1230) with automated fire extinguishing function.
- ❍ Physical Security Systems for the Data Center : CCTV System &Access Control System (ACS)

5) Improvement for Local Survey Office

- ❍ District Survey Office : To construct the Intranet within Office and supply Workstations.
- ❍ Divisional Survey Office : To apply LGN 2.0

[Table I-13] Equipment List for Local Survey Offices

Category	Equipment	Specification	Q'ty	
			Unit	Unit
District Survey Offices	L2 Switch	10/100/1000 * 24Port, 2SFP or higher	1	25 EA
	Workstation	CPU: 3.6GHz 4Core * 2ea, Memory: 32GB, HDD: 600GB x 2ea Graphic: Radeon Pro or higher	2	50 EA
	NAS Storage (Physical 10 TB)	Quad-Core Processor / DDR4 2GB / 10/100/1000 Mbps (Fast-Ethernet)/ Hot Swappable / 1U Rack Mountable	1	25 sets
	Scanner	ADF and Flatbed Scanner 1,200 DPI x 1,200 DPI (Hor. x Ver.) Scanning Speed : Mono/Color - 25 p/min	1	25 EA
	UPS	2U, 1.5 KVA or higher. Rack-type	1	25 sets
	Network Point	Exposed Outlet with UTP Laying	15	375 points
Divisional Survey Offices	LGN Router	10/100/1000 * 24Port, 2SFP or higher	1	84 EA
	Firewall	Checkpoint CP 3200	1	84 EA
	L2 Switch	10/100/1000 * 24Port, 2SFP or higher	1	84 EA
	UPS	2U, 1.5 KVA or higher. Rack-type	1	84 EA
	Network Point	Exposed Outlet with UTP Laying	2	168 points



[Figure I-23] Improvement Plan for Local Survey Office Network

6) Local Authority(Municipal Council)

- ❍ Equipment for improving the working environment of individual Municipal Council (24 locations) of the Sri Lanka LIS are as follows.(Access the WEB based LAS by internet)

[Table I-14] Municipal Council Specifications and Details of the Introduced Equipment

Category	Equipment	Specification	Unit Q'ty	Total Q'ty
Introduced equipment	LAS User PC (with LAS Client Software)	CPU : Intel Core i7-8700 (3.2GHz, 6Core) Mem : 8GB HDD : SSD M.2 256GB * 1EA, SATA 7.2Krpm 1TB * 1EA, O/S : Windows10 Pro 64bit Keyboard, Mouse, 24" LCD Monitor	2 set	48 et

5.4. Plan for Operation and Maintenance

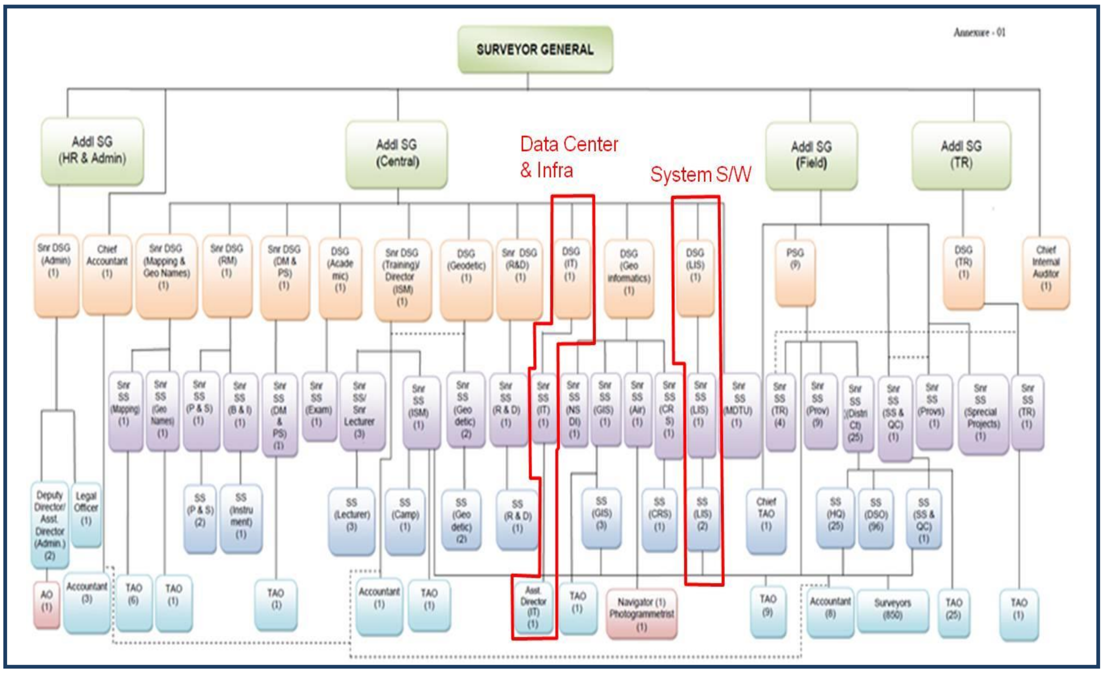
5.4.1. Organization for Operation and Maintenance

- ❍ After the completion of this project, the project management plan is presented for proper operation and management of the Survey Department (SDSL).

- ❍ Proposed operational organization composition, manpower supply and demand plan, system operation and management plan, and financing plan for practical operation.

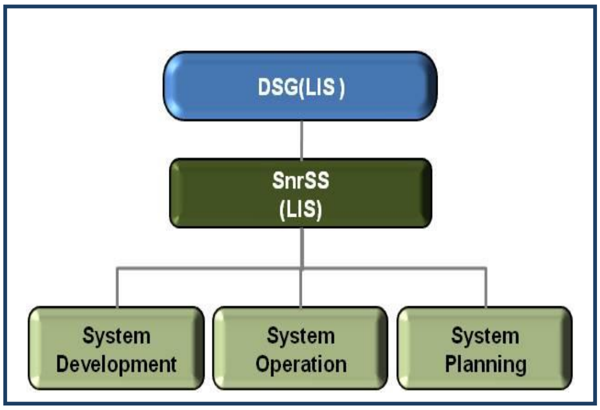
- ❍ Since the Survey Department, which conducts the project, has an LIS organization in charge for LAS and LISS and an IT organization that supports the maintenance of IT equipment, so that complements of the subordinate organizations for each department section/branch would be suggested, instead of a separate organization.

- ❍ Since the Database Acquisition Part can be operated and maintained by the existing Organization, and regional office personnel, therefore additional organization is not recommended.



[Figure I-24] Improvement plan for operational Organization

1) LAS & LISS Organization



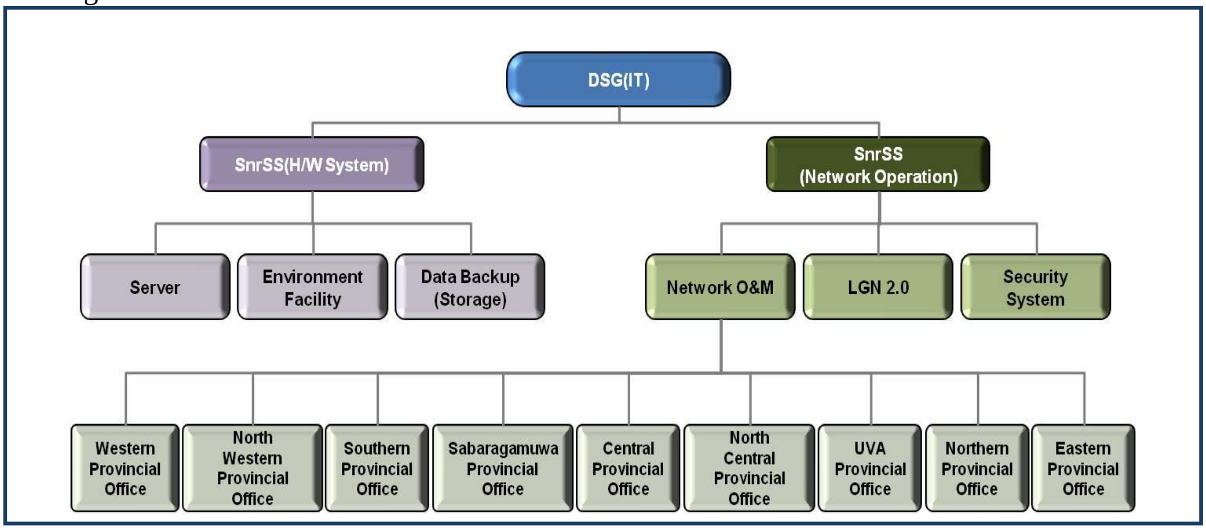
[Figure I-25] LAS and LISS Organization

❍ Detailed workforce status and grades for each sector are planned and operated as follows.

[Table I-15] Man Power Mobilization plan –LAS & LISS

Sector		Grade				Total Manpower
		Expert	High	Middle	Low	
Manager(DSG-LIS)		(1)				(1)
S/W System	Tech Leader (Snr.SS)	(1)				(1)
	System Planning		2			2
	System Operation		2			2
	System Development		2			2
Total		(2)	6			6(2)

2) IT Organization



[Figure I-26] IT Organization

❍ Detailed workforce status and grades for each sector are planned and operated as follows.

[Table I-16] Man Power Mobilization plan -IT

Sector		Grade				Total Manpower
		Expert	High	Middle	Low	
Manager(DSG-IT)		(1)				(1)
H/W System	Server Management(Snr.SS)		1	(1)		1(1)
	Environment Management			(1)	(1)	(2)
	Data Backup		1			1
Network Operation	LGN 2.0			1		1
	Security System Management			1	1	2
	Network O&M (Snr.SS)		1		1	2
	Western Province			1		1
	North Western Province			1		1
	Southern Province			1		1
	Sabaragamuwa Province			1		1
	Central Province			1		1
	North Central Province			1		1
	UVA Province			1		1
	Northern Province			1		1
	Eastern Province			1		1
Total		(1)	3	11(2)	2(1)	16(4)

5.4.2. Operational Cost

❍ Operational costs such as labor, system maintenance, building management, and electricity bills after the construction of LAS and LISS and Data Center are responsible by the Sri Lankan Government and Surveying Department (SDSL)

[Table I-17] Man Power Mobilization plan -IT

Title	Annual expected Cost(USD)	Description
Labor	269,894	Average Wage in Public Sector(22 persons)
system maintenance	1,789,200	Update and Maintenance cost 12% of System Construction cost(H/W & S/W)
IDC Rental	83,448	Annual payment for SLT IDC Space
Utility Cost	46,000	General expenses including electricity, water and gas
Total	2,188,542	

6. Capacity Building Plan

6.1. Overview of Training

❍ This project applies to various institutions and area so it requires customized effective training for various training subjects

– Invitational training to Korea for key stakeholders Managers and workers)

– Expert trainer education for mid/long-term competency reinforcement

– Local expansion training through educated trainers

– OJT for training core personnel for worker level system

– Improve effects of training by improving old training environment and facilities

6.2. Invitation Training in Korea

❍ Launch invitational training to Korea program to improve understanding for the project for public officials at SDSL and its district survey offices and 24 major districts

– Invitational training conducted for 2 weeks over 2 sessions for 60 people total (All expenses of 3 people to participate in the invitation training in Korea will be covered by Government of Sri Lanka)

– Conducted through lectures, equipment training, visiting relevant institutions, on-site experiences, etc.

[Table I-18] Invitational Training Program

Subject and Personnel	Program	
First session 30 people (Headquarters - 2 people, District – 12 people, MC – 12 people, relevant central institution – 2 people, Ministry – 2 people)	1st week	Introduction of land policy cases and domestic land development experiences in Korea Visit relevant institutions for introduction of status related to construction of advanced land information system
	2nd week	Demonstration of survey system such as UAV, TOSS, RTK Visit for land information computerization and network construction status
Second session 30 people (Headquarters - 2 people, District – 13 people, MC – 12 people,	1st week	Introduction of land policy cases and domestic land development experiences in Korea Visit relevant institutions for introduction of status related to construction of advanced land information system

Subject and Personnel	Program	
relevant central institution − 2 people, Ministry 1 people)	2nd week	Demonstration of survey system such as UAV, TOSS, RTK Visit for land information computerization and network construction status

※ Trainees are selected by SDSL and relevant organizations

6.3. Training for Fostering Instructor

❍ Education of expert trainers is necessary for consistent training and education

– Conduct intense training for key workers by field affiliated with SDSL headquarters which is the leading institution for this project

– 4 Korean experts by field shall be dispatched to local region for 2 months in ISM

[Table I-19] Subjects of Trainer Education

Trainee Affiliation	Field	Subjects (People)	Training Period	Korean Trainers(People)
SDSL Headquarters	Data center and IT network	4	2 months	2
	System (Land management system)	4	2 months	2
	Geomatix	4	2 months	2
	Data acquisition and survey	4	2 months	2
Total		16		8

※ Trainees are selected by SDSL

6.4. Expansion Training for Reinforcement of Operator

❍ Expansion training program for operation of developed system

– Local expert trainer trained through trainer education program conducts training

– 1 Supervisor per field shall participate consisting of Korean experts who conducted the trainer education program

❍ Training subjects consist of IT(Open source based), land management system operation and management, GIS based Geomatix, land registration data acquisition and direct supplementary survey, etc.

– Commended over 2 months at ISM over 4 sessions and 2 weeks per field

[Table I-20] Subjects for Expanded Training for Administrators

Affiliated Institution of Trainees	Number of Training Subjects(People)	Number of Trainees by Field(People)
SDSL Headquarters	4	1
District Offices	100	25
84 Divisional Offices	336	84
Municipality Councils	96	24

Affiliated Institution of Trainees	Number of Training Subjects(People)	Number of Trainees by Field(People)
Department of Registrar General's	4	1
Department of Land Commissioner General's	4	1
Land Settlement Department	4	1
Land Use Policy Department	4	1
Total	552	138

6.5. OJT(On-the-Job Training)

❍ SDSL experts' participation in developing the system, testing, pilot operation and etc. with Korean experts in Sri Lanka for SDSL to utilize them as key personnel for future system operation

[Table I-21] Program

Period	Subject	Personnel	Major	Goal
36 months	SDSL	6 people	System expert (GIS, IT)	Cultivate on-site technical expertise by participating in system development, installation, and testing

6.6. Training Environment Infrastructure Improvement

❍ Current training site used by SDSL is an old building which was built 50 years ago and the computer rooms and lecture rooms on site are also very old which make efficient training difficult

– Upgrade training site environment and reinforce training resources to reinforce training infrastructure

– Include 2 sets of CORS construction related GNSS transmitter and controller in training equipment

7. Consulting Service

7.1. Necessity of Service

❍ Employment of professional consultant is required to efficiently and economically execute preparation, launch, and operation of this project as well as to efficiently achieve targets such as overall quality, expenses, and atmosphere

– Consulting service shall provide basic design of the project along with bidding preparation and supervision along with foundation service for project execution

7.2. Scope of Consultation

❍ Total Period : 48 months

– Phase 1: Basic design and bidding drafting support (7 months)

– Phase 2: Contract evaluation and support (5 months)

– Phase 3: Supervision (36 months)

[Table I-22] Consultation Service Period and Key Details

Project Phase/Period		Key Details
Basic design and bidding drafting support	7 months	- Establish database, develop land information system, construct data center and infrastructure, training, draft bidding for maintenance and support work - Draft RFP
Proposal evaluation and contract support	5 months	- Support of procurement for supplier selection - Evaluate RFP from bidders and draft evaluation report - Contract support following company selection - Support over procurement period
Supervision	36 months	- Supervision of DB construction plan, results, and quality - Supervision of installation, unit testing, and overall testing - Inspection of purchase and specifications for data center and infrastructure construction - Inspection of training program propriety - Inspection of maintenance and support plan - Draft process report and completion report(Includes purchase, progress, quality, payment management, etc.)

❍ Basic design shall establish execution plans for database, system, ICT infrastructure, and competency reinforcement over 4 months in the beginning of consultation process

❍ Supervision shall inspect and evaluate the quality of product by phase over construction period(36 months) of the project

❍ Supervision shall consist of regular inspection by quarter, intermediate audit and final audit

❍ Each inspection shall consist of 2 weeks of local stay and 2 weeks of work in Korea for inspection preparation, business trip preparation, and summarization of inspection details

❍ Audit personnel shall consist of experts by field and they shall audit products throughout audit period as below:

– Land information system and ICT infrastructure shall be audited according to information system auditing standards

❍ Cadastral data construction shall be audited through direct survey and physical inspection of quality of construction product

❍ In addition, it will be added another three (3) more months to the project period because of the procedure to select the PMC (Project Management Consulting)

7.3. Human Resource Management Plan for the Consultant

1) Consultant Composition

- Consultation service for this project is divided into 3 phases with the project being executed with expert groups by field of database, system, data center, ICT infrastructure, and competency reinforcement which are key areas of the project by phase

- Phase 1 consists of basic design and bidding drafting, phase 2 consists of RFP evaluation and contract support, and phase 3 consists of supervision of construction and composition of experts for consultation service is as below

[Table I-23] Composition Plan of Experts for Consultation Service

Phase		Personnel (M/M)			Key Work Details
		Grade	Foreign Expert	Local Expert	
Phase 1	Basic design, preparation RFP	Special	38.00	11.00	- Basic design and RFP preparation on the field of CORS construction, mapping digitalization, UAV surveying, spatial DB, land management system and data center
		Advanced	30.00	-	- Basic design and RFP preparation on land administration system, IT network, capacity building - Project management
Phase 2	Support in evaluating proposal and contract negotiation	Special	20.75	-	- Support in evaluating the proposal and contract negotiating on the field of the construction of CORS, mapping digitalization, UAV surveying, spatial DB, land management system and data center
		Advanced	7.00	-	- Support in evaluating the proposal on capacity building - Project management
Phase 3	Supervision	Special	63.00	36.00	- Supervision on the field of CORS construction, mapping digitalization, UAV surveying, spatial DB, land management system and data center
		Advanced	69.00	-	- Supervision on land administration system, IT network, capacity building - Project management

8. Operation and Maintenance Support Plan

8.1. Type and Period of Operation and Maintenance Support

1) Type of Operation and Maintenance

[Table I-24] Details of Operation and Maintenance

Category	Details	Form of Support
Correction(Defect) and Maintenance	- Error correction, correction of inconsistency with function specification sheet - Output of inappropriate information - Transaction error	Maintenance free of charge

Category	Details	Form of Support
	- Inconsistency with function specifications and design details - Abnormal termination of program - Other functional defects	
Adaptation Maintenance	- Maintenance to allow use in other environments when system changes due to change in operational environment and relevant laws - Change in classification code and DB within scope of design - System monitoring and reflect demands from work manager - Tuning of functions and modules outlined in project agreement	Maintenance at cost after warranty period
Function Correction and Expansion Maintenance	- Maintenance conducted upon occurrence of performance improvement factors due to new technology - Structural adjustment of software - Expansion of system functions - Change to upper level hardware for system version upgrade - Additional construction for DB	Conducted according to maintenance agreement

2) Maintenance Period

❍ Stable support of maintenance and technical support are essential for the smooth operation of the system, and various technical support and stabilization activities are essential through the post-maintenance team.

– Contractor guarantees defect-free warranty for system equipment delivered after completion of system construction

– for 2 years

– However, for the equipment and equipment initially delivered for drawing computerization and ledger

– computerization, 2 years warranty will be provided based on the equipment delivery date

– To establish a maintenance system to systematically respond to rapidly changing information technology, conduct

– preventive inspections in advance, and prepare measures to respond immediately to any failures

8.2.Operation and Maintenance Support Plan

1) Land Administration System and Land Information Service System

❍ Keeping the Sri Lanka land information management system stable, securing sustainable business procedure, establishing emergency preparedness system and rapid and immediate response system in case of failure will be established

– It is necessary to maintain systematic maintenance activities for two years (24 months) after completion of the completion inspection to improve the stable operation and operational efficiency of the system

❍ To support the maintenance of the system smoothly, the Survey Office (SDSL) has established a maintenance support team to enable the operation of Sri Lankan users and professional contractors

– Operational maintenance support team by contractor supports stable operation by dividing into resident period (12 months) and non-resident period (12 months)

❍ Target of system maintenance is limited to the function of the application system in operation after the completion of development

– Includes technical assistance for the handling of failures and other normal operation of the system

– Performed separately for free maintenance and paid maintenance

[Table I-25] Scope of Maintenance at Cost

Category	Scope of Support
Maintenance Period	- After expiration of warranty period
Scope of Maintenance	- Details of system installation related to added functions and expansion, design change for performance improvement in H/W, DB, etc. - Damage caused by natural disasters and user errors, S/W subject to maintenance at cost according to implemented commercial S/W vendor policy - Other matter not included in defect repair
Details of Support	- Determine scope of execution and budget scale through negotiations with ordering organization for maintenance at cost

2) Land and Spatial Information DB

❍ To secure the stability and utility of the Sri Lankan land information system:

– Maximize data efficiency and secure DB reliability

– Establish work regulations and settle early

– DB localization support and immediate data error processing

❍ Primary maintenance activities consist of immediate response and correction of data errors that may occur despite the inspection process such as self-inspection of DB construction process and supervisor confirmation.

❍ Secondary maintenance activities consist of DB actualization support activities for early establishment of DB construction work regulations and related technologies created in consultation with Sri Lanka's surveying agency during DB construction process.

❍ Third maintenance activity is the support area following the update of DB data and it is limited to the update of the built DB, not additional construction.

❍ Maintenance of equipment provided for surveying and DB construction is divided into free maintenance and paid maintenance through cooperation with local agency companies. Free maintenance is defined according to the maintenance policy of the supplied equipment manufacturer

3) Data Center and Infrastructure

❍ Maintenance support for data center and infrastructure of Sri Lanka Land Information System is confined to the network equipment, server system, facility equipment and etc. provided by the contractor, and maintenance period consists of Six(6) Month resident maintenance period One(1)-year shift work and Six(6)-month remote support period.

- ❍ Scope of maintenance support includes Hardware A / S for systems installed in the main data center of the survey office main office, the backup data center installed in the NLT of the SLT, and the systems supplied to 25 district survey offices and 84 divisional survey offices. Includes system operation management, such as software up-grade and fault handling.

- ❍ Warranty period for the above products is 2 years after the handover (Total 3 Years including one year for the construction schedule),

- ❍ After Warranty, it is expected to be considered about 12% of the Construction cost.

- ❍ Data center and infrastructure builders of Sri Lanka land information systems should establish detailed maintenance support plans as follows.

  – Store modules and products of high disruption frequency or major equipment at a certain ratio
  – Establish a plan to utilize local suppliers from the start of construction for rapid response
  – For global vendor products, support system is provided through local A / S system and neighboring countries
  – Establish a cooperative system between resident maintenance personnel and construction equipment vendors
  – In order to increase the IT technical capability, it is required to involve local personnel from the initial stage in construction phase of land data infrastructure system

- ❍ Sri Lanka Land Information System's data center and infrastructure construction project maintenance staff plan is as follows

  – Considering the trouble shooting that may occur in the early stages after the completion of the LIS construction, IT specialists should stay in the SDSL HQ for Six(6) Months and conduct the concentrated support period, then One(1) Year shift work and provide remote support for Six(6) Months thereafter.
  – Two(2) specialists in total: One(1) Network and Hardware specialist and One(1) Information Security Facility specialist

[Table I-26] Infrastructure Maintenance Personnel Plan

Category	Detailed Tasks
Common	- Preventive inspection and maintenance by equipment - Disruption processing and support upon occurrence of disruption
Network and server specialist	- Network equipment and server, Storage, Backup system management - Equipment operation and local staff training
Information security facility specialist	- Security system management - Equipment operation and local staff training

4) Capacity Building

- ❍ Six Korean experts from different sectors will be dispatched in Sri Lanka to provide additional training for the smooth operation of Sri Lankan operators after the project as below.

[Table I-27] O&M Support Personnel Plan of Capacity Building

Classification	Details
Land and Spatial Information Sector	- Advanced class 1person in GNSS CORS * 2weeks * 4times (1 time per quarter * 4 quarters)
	- Advanced class 1person in UAV field * 2weeks * 4times (1 time per quarter * 4 quarters)
	- Advanced class 1person in DB/engine/server/integration * 2weeks * 4times (1 time per quarter * 4 quarters)
Land Information System Development Sector	- Advanced class 1person in application program/web service * 2weeks * 4times (1 time per quarter * 4 quarters)
	- Advanced class 1person in network field * 2weeks * 4times (1 time per quarter * 4 quarters)
Data Center and Infrastructure Sector	- Advanced class 1 person in security field * 2weeks * 4times (1 time per quarter * 4 quarters)

8.3. Operational Spare Part Lists

❍ Spare parts support for Sri Lanka land information system is to operate land information system stably by possessing important equipment, modules, and parts in advance in order to quickly maintain IT infrastructure system failure and damage

– Spare parts budget required for each system is allocated 2% of the ICT infrastructure budget to the spare parts budget, referring to the case of other EDCF projects

– Criteria for selecting spare parts are prioritized by selecting failure frequency and system importance

– System builder shall supply spare parts according to the selection criteria of spare parts as shown in the example below.

[Table I-28] Operational Spare parts Provision Plan

Category	Operational Spare parts
Network/Security	Main Process Module, Interface Module, Power Module, L2 Switch, UTM, 1G SFP Transceiver, etc.
Server/Storage	HDD, Memory, NIC Card, HBA Card, FC Card for storage, etc.
Infrastructure	UPS, Circuit breaker, Cooling fan, Fuse, key components for fire extinguishing equipment, anti-humidity and constant temperature components, CCTV, etc.

9. Project Budget Calculation

9.1.Estimated Budget

❍ Total budget for execution of this project is estimated at 60,330,000 USD based on the results of feasibility survey

[Table I-29] Estimated Budget

(Unit: 1,000 USD)

Item	EDCF				GoSL	Total
	Foreign Currency		Local Currency	EDCF Total		
	Korea	3rd Countries				
1. Land and Spatial Information DB	5,267	5,192	15,804	26,263		26,263
2. Land Information System Development	7,272	81	1,187	8,540		8,540
3. Data Center and Infrastructure	2,011	4,087	106	6,204	166	6,370
4. Capacity Building	897	274	469	1,640	307	1,947
5. Consulting Service	3,864		506	4,370		4,370
6. Operation & Maintenance Support	1,405	78	204	1,687		1,687
7. PMU(Project Management Unit)					680	680
Direct Cost	20,716	9,712	18,276	48,704	1,153	49,857
8. Taxes and Duties					4,285	4,285
9. Contingency	1,683	1,292	3,159	6,134		6,145
10.Service Charges EDCF loan	54			54		54
Total Budget	22,453	11,004	21,435	54,892	5,438	60,330

* All taxes, duties, and levies imposed on goods and services in the democratic socialist republic of Sri Lanka provided by the Suppliers will be exempted by the Government of Sri Lanka.

9.2. Funding Plan

❍ Total budget for execution of this project is estimated at 60,3330,000 USD based on the results of feasibility survey and;

– 91% or 54,892,000 USD will be funded through loan from EDCF

– 9% or 5,438,000 USD will be funded by the Government of Sri Lanka

[Table I-30] Estimated Budget

(Unit: 1,000 USD)

Item	EDCF				GoSL	Total
	Foreign Currency		Local Currency	EDCF Total		
	Korea	3rd Countries				
Project Cost	22,453	11,004	21,435	54,892	5,438	60,330
EDCF Ratio (%)	40.90	20.05	39.05	100.00		
Ratio (%)	37.217	18.240	35.530	90.986	9.014	100.000

9.3. Annual Fund Expense Plan

[Table I-31] Annual Budget

(Unit: 1,000 USD)

Item	Y0*	Y1	Y2	Y3	Beyond Y4	Total
EDCF	1,757	18,480	19,925	6,855	1,687	48,704
GOSL		328	412	413		1,153
Total of Direct Cost	1,757	18,808	20,337	7,268	1,687	49,857

* Project preparation period before selecting the main contractor to construct the system

10. Project Feasibility Analysis

10.1. Policy Feasibility Analysis

❍ The Policy feasibility analysis of the Sri Lanka land information system construction project sha ll apply the policy evaluation criteria of the 「Standard Guidelines for Conducting Preliminary Feasi bility Studies for Overseas Projects in Public institutions. (2013), Korea Development Institut e」.

– Assessing the coherence of the national policy and higher-level plans.
– Evaluate the project willingness and preference of recipient countries.
– Organize the necessity of projects based on national policy and willingness to pursue projects.
– Evaluate the feasibility of the policy by analyzing the risk factors expected in the project promotion.

[Table I-32] Policy Evaluation Criteria]

Evaluation Criteria	Details
Consistency with National Policies and Relevant Upper Level Plans	- Review consistency with national institutions and policy directives - Evaluate whether the project appropriately reflects the upper level plans or other relevant plans
Project Willingness and Preference	- Evaluate attitude and willingness of project conducted by managing department and overseas business related departments
Project Necessity	- Determine specificity, personnel, resource input of project

1) Consistency with National Policies and Relevant Upper Level Plans

❍ Sri Lanka supports the Re-engineering Government as a top priority as part of the e-Governmen t project, and has selected the Provincial Land Management System (PLMS) as one of the to p 30 tasks for the Re-engineering Government. Through this, national policy on land manageme nt is in progress.

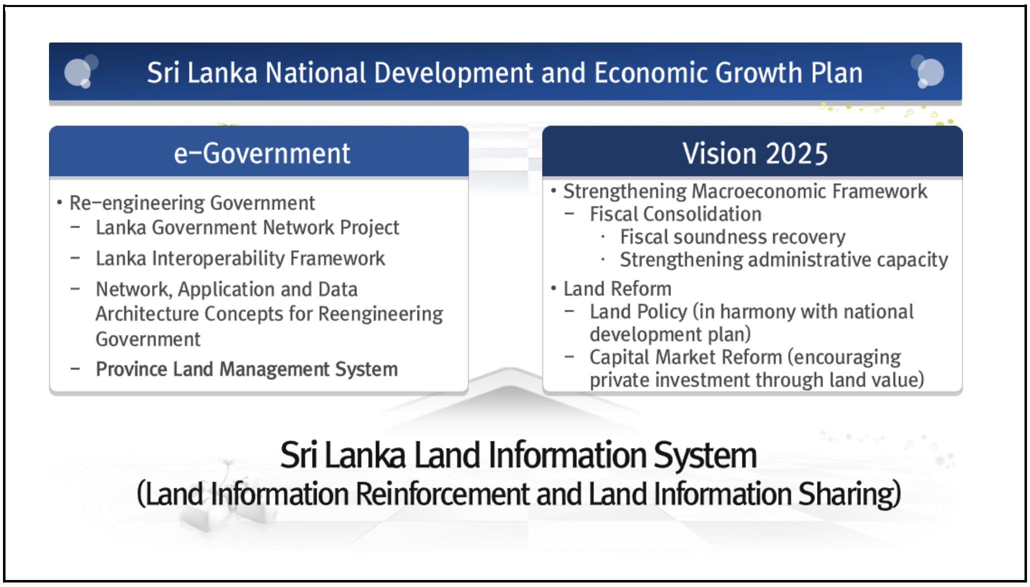
❍ In addition, the National Development Plan Vision 2025 was established to promote ICT technologie s for national land management, while pursuing sound administrative capacity and fiscal consolida tion through transparent and efficient land management.

❍ Fiscal consolidation through land reform is a fundamental means of strengthening the macroeconomi c framework, which is a priority for Sri Lankan national policy and related plans.

❍ This policy foundation is based on the Spatial Information System for the administrative capacit y of the Sri Lankan government, and is promoting “decision making and sustainable develop ment through effective use of spatial information”.

❍ Therefore, the land and national spatial information system based on land information of Sri Lank a is becoming a major national project beyond the social, economic, and policy dimensions, and will play a role as a medium for stimulating Sri Lanka's next-generation economy.

- This project provides “computerization of land data” and “land administration business unification system” and establishes a joint utilization system of land information. Therefore, This project is not only compatible with Sri Lanka's national development plan, but also with the relevant plans in each sector.



[Figure I-27] Consistency With National Policy

2) Project Willingness and Preference

- Sri Lanka has a strong commitment to build “Sri Lanka Land Information System” to achieve e-Government and Vision 2025, and e-Government and Vision 2025 are based on pre-emotive computerization of land information such as the current land use status as well as the systematic system for improving land registration rate. It includes shortening of process time and joint use of related agencies for land information.

- Also, the project provides computerization of existing land information, land administration system, land information sharing system, and related infrastructure. It is composed not only by the participation of Korean technicians but also by localization by improving technology of local engineers in Sri Lanka. In addition to Survey Department of Sri Lanka, Ministry of Lands Parliamentary reforms and Municipal Councils also give preference to projects.

- Therefore, the Sri Lanka government hopes that the establishment project of Sir Lanka land information system through Korea's EDCF will be launched sooner (They hope to launch it in 2020), and Sri Lankan related ministries are actively paying attention and efforts, which makes it highly feasible in terms of the willingness and preference of Sir Lanka.

3) Risk Factors of Project

- Risk factors in implementing Sri Lanka's land information system include political issues, the possibility of financing, social balanced development, and special factors of the project.

  – Political plan : Presidential election(2019.11.16); Cabinet composition may change according to presidential election results.

– Funding : Sri Lanka's economic growth rate continues to grow, but the growth rate of manufacturing base is slow.

– The economic growth rate after this project cannot be predicted only positively, so there are risk factors due to repayment of loans.

– Socially balanced development: There are risk factors that can cause another variable in land registration due to the increase of national tax burden due to land registration.

– Special Factors of the Project: This project is an ICT-based new technology introduction project, which requires the active participation of local engineers and the willingness to acquire technology to localize the technologies in Sri Lanka.

10.2. Propriety of Project Scope and Subject

❍ Data construction and system development sectors of this project should be the first priority under the policy of Sri Lanka.

❍ It has a project scope considering the continuous development of Sri Lanka land information system, so that both its effectiveness and sustainability are satisfied.

❍ In the data construction section of this project, target areas are defined by four major projects

❍ The computerization of existing survey plans is 82,303 Old Survey Plans throughout Sri Lanka, which consists of a total of 3,275,622 parcels. The target area is appropriately constructed because it can be performed during the project by using 50cm satellite ortho-images for geo-referencing of the scanned survey plans.

❍ Spatial DB construction subject through UAV surveys and on-site complementary surveys of approximately 708㎢ for 24MCs can be carried out within the project period. Therefore, this subject is properly organized.

❍ To facilitate the use of land information system, the construction of one data center and one backup center and the improvement of the network environment and facilities of the 25 district survey offices are considered to be appropriately configured.

❍ Expansion of the network environment for 84 divisional survey offices in 25 district survey offices maximizes practical utility and is considered to be appropriate.

10.3. Technological Feasibility Analysis

10.3.1. Applied Technology

❍ Database construction technology can be largely classified into core technology based on computerization of old survey plans and spatial information DB construction technology by 24 MCs

– Core technologies of computerization of existing survey plans are classified into 50cm satellite ortho-images production technology for geo-referencing scanned old survey plans into a unified coordinate system, reference point extraction technology for geo-referencing from satellite orthoimages, parcel boundary digitizing technology from geo-referenced survey plans, and spatial DB construction technology.

– Core technologies of spatial DB construction for 24MCs are classified into UAV survey technology, on-site complementary survey technology, and spatial DB construction technology. UAV survey technologies consists of UAV flight planning technology, UAV flight and sensor data acquisition technology, data processing technology and technology to extract parcel objects (including building objects and street objects) using orthoimages.

– Core technologies for the additional installation of CORS that can promote GPS survey technology throughout Sri Lanka are divided into VRS correction data generation technology and VRS measurement technology.

❍ Development of land information system applies open source-based program development technolo gy to minimize distribution and maintenance costs

– Map editing program is developed by Stand Alone method and map inquiry program is developed by Web GIS method

– Field survey system is developed in Android based on JAVA programming language

– Database adopts an efficient Oracle database for stable linkage with existing databases and for searching large spatial information.

– Development methodology applies the agile software development in consideration of the characteristics of the project being developed remotely

❍ Data center and infrastructure construction technology standards comply with TIA (Telecommunicati on Industry Association) data center standards (TIA-942 : Data Center Standards Overview)

– ICT field technology for center network composition

– Information security technology to minimize the influence of the system by intrusion and attack by unauthorized persons

– Environment building technology for smooth operation of data center

10.3.2. Propriety of Applied Technology

❍ The reference point extraction of Old Survey Plans using 50cm satellite ortho-images involves t he use of a universal technology in its completion stage. Thus, it is far more effective in terms of time and cost than applying field survey technology and its appropriateness is found to be ve ry high.

❍ The spatial database construction by UAV survey is a universal, specialized and mature technolog y in the Korean market. The appropriateness of applying the UAV survey technology of Kor ea to build a spatial database for the MCs in Sri Lanka was found to be high. The maturity and co mpetency in relation to Sri Lanka's local UAV survey technology are inadequate, but in case of pursuing capacity building in an ongoing manner during the project period, the technology w ill have very high utility in Sri Lanka as a sustainable survey technology.

– In Korea, based on the technology and know-how accumulated over many years, a project of constructing spatial information of coastal areas and major tourist attractions in Jeju Island by

UVA survey is underway

- As for the VRS correction data generation technology and VRS survey technology concerned in additional installation of CORS Network, they were found to be highly useful technologies in t erms of cost-effectiveness because there are already six CORS stations in pilot operation. T hrough sustainable services, it will contribute to dramatic advancement of the GNSS survey t echnology across Sri Lanka.

- Globally, open source-based GIS systems have been proven to be technically stable and are bei ng used on multiple sites. Web GIS system components based on open source GeoServer, Open Layers, Apache, and Tomcat have been confirmed to be compatible with existing Sri Lanka S ystems. It is a system that can be maintained and managed stably by applying an open source ba sed solution rather than an exclusive license, and meets the requirement of Sri Lanka.

- The secured stability and security for operation of LAS and LISS through redundancy of netwo rk facilities and information security facilities such as backbone and L4 / L7 switch, and h ot site configuration through periodic data synchronization between main data center and back up data center. Appropriate facilities (constant temperature and humidity and fire extinguishing equipment) for power redundancy (always & emergency), uninterruptible power supply, an d data center environment configuration are supplemented to supplement the limitations cau sed by utilizing existing buildings.

- According to the selection of equipment (WAS & DB Server) considering the server I/O transacti on according to concurrent users (expected value), ICT core technologies such as server virtuali zation and backup devices are secured. Effectively reflected in the design and found to be appr opriate.

10.4. Propriety Analysis of Budget

10.4.1. Budget Composition

- Cost of Sri Lanka land information system construction projects is divided into seven major categori es, and the cost of each sector is divided into those of Sri Lanka, Korea, third countries, and recip ient countries

- Total budget is estimated at project cost of USD 60.33 million, direct project cost of USD 50.0 3 million, and other contingency and taxes are estimated at USD 13.49 million

10.4.2. Propriety of Budget Calculation

[Table I-33] Budget Composition

(Unit: 1000 USD)

Category	Estimated Budget	Ratio	Budget Propriety
Land and Spatial Information DB	26,263	43.54%	The cost of database construction is broken down by each construction process, and the project cost is calculated to maintain appropriateness to effectively cope with the fluctuation risk caused by the increase or decrease of quantity. 53.68% of database construction costs are made up of Sri Lankan local technicians, so the project cost ratio reflects localization of surveying and DB construction technology.
Land Information System Development	8,540	14.16%	The cost estimation method based on the function point is calculated based on the function regardless of the technical level of the domestic developer and the local developer in the recipient country and can provide rare proof to apply benefit for Domestic developer and the local developer. S / W is not suitable for measurement, and the project cost for system construction of this project is calculated by the manpower calculation As a result of comparing the cost of manpower input and the function point method, the cost of manpower input method is similar to the 95% of the function point method cost
Data Center and Infrastructure	6,370	10.56%	Cost calculation is based on the standard wage unit cost by sector and is appropriate. - Applicable standard: technician wage unit price in 2018 S/W engineering and telecommunication engineering - The performance and capacity calculation is based on the Korea Information and Communication Technology Association (K-TTA) 'Information System Hardware Sizing Guidance', and is based on monthly price data (Korea Price Association), manufacturer's quotation and market price survey.
Capacity Building	1,947	3.23%	Cost calculation is based on the standard wage unit cost by sector and is appropriate. - Applicable standard: technician wage unit price in 2018 - Costs for capacity building for Sri Lanka land informatization projects; Includes costs for invitation training in Korea, instructor training, expansion training for system operators, OJT, and education infrastructure improvement
Consulting Service	4,370	7.25%	Cost calculation is based on the standard wage unit cost by sector and is appropriate. - Applicable standard: : technician wage unit price in 2018 S/W engineering and telecommunication engineering
O&M Support	1,687	2.80%	Cost of maintenance support for 24 months after project completion
PMU	680	1.13%	It was set as the government cost of Sri Lanka, and was properly organized as the operating cost of the project organization.
Contingency and Taxes	9,723	17.37%	The physical contingency was estimated at USD 2,433,000 (5% of direct project cost) and USD 3,701000 for price reserve. Tax and duties were calculated by the provider VAT 15%, PAL 7%,

Category	Estimated Budget	Ratio	Budget Propriety
			average TAX 10.3% etc. * All taxes, duties, and levies imposed on goods and services in the democratic socialist republic of Sri Lanka provided by the Suppliers will be exempted by the Government of Sri Lanka. EDCF Loan fee is 0.1% of direct project cost according to EDCF guidelines.
Total Estimated Budget	60,330		The overall project cost was appropriately assigned to the existing projects for Sri Lanka's nationwide drawing computerization project, 24 major urban spatial information construction, land information system development, and data center construction, and the project cost was distributed evenly by sector.

- Land and Spatial Information DB construction project cost is broken down by each constructi on process, and the project cost is calculated to maintain the appropriateness to effectively cope with the fluctuation risk caused by the increase or decrease of quantity. In addition, 60.208% of the project costs are made up of Sri Lankan local engineers, so the project cost ratio re flects the localization of surveying and DB construction technology.

- The system development division is designed to share the development results and reflect t he requirements to the system by inputting an average of 10 development personnel to Sri Lank a five times during the development period. About 20% of the development work is designe d to be developed by local developers, so it is appropriately configured to enable system maint enance in the private sector in the future.

- The data center division is constructed to enable stable operation of the Sri Lanka LIS by establishin g a main data center and a backup data center, and include improvement of the operational environ ment of the District Survey Office and improvement of facilities of the Divisional Survey Office. Th erefore, since it includes overall improvement costs from land-related work to administrative s ervices, it shows the appropriateness of project cost composition to prevent additional costs.

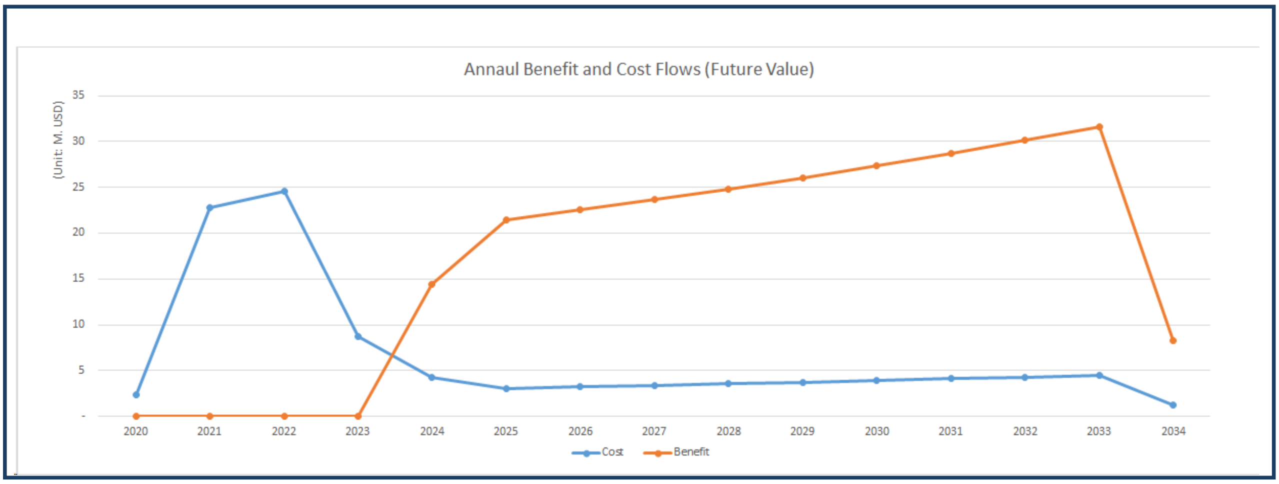
10.5. Economic Feasibility Analysis

- An economic feasibility analysis of the Sri Lanka LIS project was carried out based on t he benefit-cost analysis method.

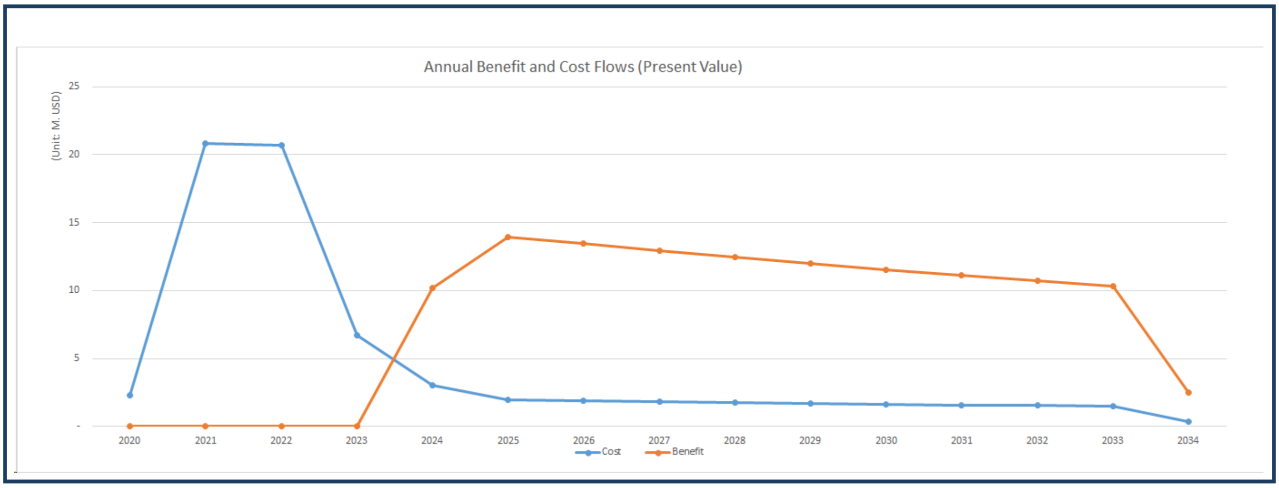
- The economic feasibility of the project was analyzed centering on social benefits and costs usin g the net present value (NPV), benefit/cost ratio (B/C ratio), and economic internal rate of r eturn (EIRR) and a sensitivity analysis was carried out.

- The USD-LKR exchange rate used in this feasibility analysis was 175.43 LKR per dollar (15-d ay average sell rate from June 28, 2019 to July 12, 2019), and the USD-KRW exchange rate that was applied was 1,172.55 KRW per dollar.

- In reference to a similar project,[7] the total analysis period was 15 years.
- The project is expected to take a total of 51 months from the date on which the loan agreem ent becomes effective, and it was assumed that the benefits of the information system built would last for 10 years.
- The total cost of this project was estimated at USD 60,330,000
- Operating costs were estimated by categorizing them into (1) labor costs, (2) maintenance costs, (3) IDC rental costs, and (4) electricity charges.
- The following figures show the cash flows of annual costs and benefits in terms of future a nd present value.



[Figure I-28] Annual Cost and Benefit Flow (Future Value)



[Figure I-29] Annual Cost and Benefit Flow (Present Value)

7 Ethiopia National Standard Integrated Land Data Infrastructure Master Plan, Korea Eximbank, 2018

- Benefits were estimated by categorizing them into the following: (1) Faster access to land informatio n for citizens; (2) Reduced transportation costs for citizens trying to access to land information; (3) Increased productivity of public servants performing land management; and (4) land tax in come increase.

- Benefit-cost analysis results: Since the NPV is greater than zero, the B/C ratio is greater than 1. 0, and the EIRR is greater than the social discount rate (9%), the project is economically feas ible.

[Table I-34] Benefit-Cost Analysis Results

NPV	B/C ratio	EIRR
51,722,988 USD	1.75	21.50%

- Sensitivity analysis with respect to the changes in discount rate, cost, and benefits was also performe d.

- From the sensitivity analysis results when the discount rate changes from 6% to 12%, even in the worst case of 12%, the project has economic feasibility because the NPV is greater than zero and the B/C ratio is greater than 1.0.

- From the sensitivity analysis results when the cost changes from -20% to 20%, even in the wor st case of 20% cost increase, the project has economic feasibility because the NPV is greater than zero, the B/C ratio is greater than 1.0, and the EIRR is greater than the social discount r ate.

- From the sensitivity analysis results when the benefit changes from -20% to 20%, even in the wor st case of 20% benefit decrease, the project has economic feasibility because the NPV is greater than zero, the B/C ratio is greater than 1.0, and the EIRR is greater than the social discount rate.

- Even in the worst case scenario where the costs increase by 20% and benefits decrease by 2 0% at the same time, the project has economic feasibility because the NPV is greater than zero, the B/C ratio is greater than 1.0, and the EIRR is greater than the social discount rate.

11. Performance Management Framework for the Project Result

11.1. Necessity for Performance Management

- Performance indicators measure project progression and suggest future direction for the project and it is utilized in the performance management framework for efficiency

- Proceed with strategic land information system construction project for Sri Lanka through digiti zed(Quantified indicators) performance management plan

11.2. Subjects of Performance Management

11.2.1. Key Projects

- Key subjects of the project to performance management are as listed as below:
  - Construction of Land and spatial DB
  - Development of Land Information System
  - Construction for Data Center and infrastructure
  - Capacity Building
  - Consultation service

11.2.2. Calculation of Targets for Key subjects of the project

- Construction of Land and spatial DB
  - Computerization of cadastral maps of 3.5 million parcels, DB construction for 24 Municipal Councils, Establishment of DB for LISS and 32 sites of GNSS CORS

- Development of Land Information System
  - Automation of land registration and provision of spatial information service through development of Land Administration System

- Construction for Data Center and infrastructure
  - Construction of central data center and backup data center
  - Network environment and equipment improvement of local districts

- Training
  - Training by relevant institution at project area (Local trainers – 16 people, Expansion training trainees – 552 people)
  - Invitational training to Korea(30 people*2 times*2 weeks)

- Consultation service
  - Basic design and bidding preparation support (7 months)
  - Proposal evaluation and contract support (5 months)
  - Quality and process management (36 months)

[Table I-35] Performance Targets

Category	Details	Target
Land and spatial DB construction	Cadastral map production: Computerization of cadastral maps	Computerization of 3.5 parcels
	DB construction(Buildings, roads)	DB construction for 24 major districts
	Spatial information DB	Land Information Service System(LISS) DB
	GNSS CORS network setup	Establish 32 offices nationwide
	Utilization of satellite image	Resolution 50cm/ortho-images
	Land Administration System construction	Automation of land registration
Land Information System development	LISS construction	Land and spatial information service
	Field note entry and construction of search module	Field note entry done by SDSL
Data center and infrastructure construction	SDSL central and back-up data center	Central data center
	SDSL local data center infra	25 district survey office
	local data center network	84 divisional survey office
	Municipal Council connection equipment	Supply of LAS User PC for 24 MC
Capacity Building	Invitational training to Korea Local trainer education and local expansion training	
Consultation service	Basic design, support for procurement proposal evaluation and contract negotiation, supervision, etc.	

11.3. Performance Indicators

❍ Derive performance indicators covering the main objectives of individual parts for building land information systems

❍ Check the progress by dividing the mid- to long-term effects, calculation results and output into three sections

11.3.1. Performance Indicator Measurement Method and Data Sources

❍ Measure and measure each performance indicator and check the achievement rate of each item against the original plan

❍ Currently, SDSL publishes a white paper every year to build various statistical data, and secures data on performance indicators by making the progress of this project into a separate chapter of the SDSL white paper.

- Refer to related reports from the Sri Lankan Statistical Office, PMU and World Bank.

11.3.2. Mid/Long-term Indicators

❍ Improvement of land registration rate and increase of online service use rate as indicators to increase national convenience and convenience by strengthening capacity of land administration government and increasing information accessibility

11.3.3. Calculation Result Indicators

❍ Establishment of the following standards to improve the efficiency and accuracy of land administration

– (Efficiency) Shorter land registration administrative processing period
  - 14 days → 3 days after construction (application → issue, except holiday)

– (Efficiency) Speeding up processing of land information inquiry
  - 1 minute per present case → Within 10 seconds after construction

– (Accuracy) Improving Accuracy of Land Administration
  - 15 days of field survey after survey data acquisition → 3 days after construction

11.3.4. Product Indicators

❍ Land and spatial DB construction: Construction of 32 CORS, 50CM-class, satellite orthodontic images, digital drawing and database of 3.3 million parcels, 24 MC's intellectual DB and spatial DB, surveying equipment(GPS, UAV, scanner and related SW)

❍ Land information system development: Land registration system, land information inquiry system, cadastral map management system, survey application information management system, survey result creation and inspection system, field survey support system, survey document management system, civil service portal system construction

❍ Data center: New data center and backup center operation equipment, 25 regional office sub network and equipment construction

❍ Education and Training: Build customized training programs and training tutorials, local instructors, training equipment (H/W, S/W)

[Table I-36] Performance Indicators

Design Summary	Indicators (Baseline/Targets)	Data Sources	Assumption/Risks
1. Mid/Long-term Effects			Assumption: Stable operation and spread of 24MC land information system Risks: - Avoidance of land registration (tax generation, etc.) - Change of personnel in accordance with
1.1 Land Administration Competency Reinforcement	1.1.1 Improvement of Land Registration Rate (Bim Saviya Program) - (2019) 1,250,000 parcels > (2030) 3,450,000 parcels	SDSL Annual Financial Report and Statistics	

Design Summary	Indicators (Baseline/Targets)	Data Sources	Assumption/Risks
			personnel movements -Inadequate legal system and distribution system to utilize computerized data
2. Calculation Results			Assumption: Promoting the nation's active system nationwide Risks: - shortage of manpower - shortage of local private company - shortage of law frame for digital land survey -incorrect existing data
2.1 Land Administration Efficiency Improvement (Governmental)	2.1.1 Shortening Land Registration Administrative Processing Period -(2019) 14 days -> (2027 / after construction) 3 days	- SDSL Annual Financial Report and Business Statistics - Direct survey (survey, interview)	
2.2 Land Administration Accuracy Improvement (Public)	2.2.1 Annual online service access -(2019) count: 0 -> (2027) count: 360,000	- SDSL Annual Financial Report and Business Statistics - Land administration and Land information system performance report	
3. Product: Construction of Integrated Digital Land Administration System			Assumption: securing political stability (budget, etc.) for smooth business Risks: ① Prediction of cloud for satellite imagery, ② Lack of local partners in competitive private sector, ③ Establishment of stakeholder relations, ④ Lack of skill of manpower
3.1 Computerization of Surveying and Cadastral Information	3.1.1 Installation of 32 CORS 3.1.2 Establishment of 50cm satellite ortho-images throughout Sri Lanka 3.1.3 Digitalization of Old Survey Plans and establishment of graphic cadaster for 3.3 million parcels 3.1.4 Construction of parcel fabric for the 24 MC’s	Completion report SDSL project monitoring (PMU) report	
3.2 Land administration system and land information service system establishment	3.2.1 Land administration and land information service system consisting of eight business systems including land registration system and cadastral map management system	Completion report SDSL project monitoring(PMU) report	
3.3 Data Center and Operational Infrastructure	3.3.1 Construction of new data center (57.87 ㎡)and backup center operation facilities 3.3.2 25 regional office sub-networks and equipment (25 sets) 3.3.2 Improvement of network condition for 84 divisional office (84 sets) 3.3.2 LAS User PC for 24 Local Authorities.	Completion report SDSL project monitoring(PMU) report	
3.4 Training capacity building	3.4.1 Number of Completion of Korean Invitational Training Program: 60 3.4.2 Number of local instructor training program participants: 16 3.4.3 Number of students who	Completion report SDSL project monitoring(PMU) report	

Design Summary	Indicators (Baseline/Targets)	Data Sources	Assumption/Risks
	completed diffusion education program through nurtured local instructors: 552		

Primary Beneficiaries
-Land administrator
-Land information utilization agencies (most government agencies such as local governments, surveying offices, local survey offices, courts and the Ministry of Land, Infrastructure and Transport)
-Sri Lankan people

Goals
-Strengthen land administration capacity and activate land information sharing

Monitoring
- Hiring a consultant (3 months after the effective date of L/A)
-Purchase agreement (12 months after the date of signing of the Consulting Contract)

[Table I-37] Definition of Performance Indicators by sectors

Indicator / Target year/ Target	Definition and contents	Source	Indicator officer
Accumulated land registration count /2030/3.45 million	- Accumulated number of registered land registrations by 2030. - The accumulated number of land registrations in Sri Lanka at the end of 2018 is about 1.25 million, with an additional 150,000 entries being registered annually. - It is assumed that an additional 250,000 pages will be registered annually after the system is deployed, and 200,000 will be registered in the transitional period. - 900,000 cases (150,000 x 6 years) between 2019 and 2024, 400,000 cases (20,000 x 2 years) between 2025 and 2026, and 1 million cases (250,000 x 4 years) between 2027 and 2030 (25,000 x 4 years) That is, an additional 2.3 million entries have been registered, resulting in a cumulative 3.45 million entries.	- Annual financial reports and business statistics of SLD - Report on Land Administration and Land Information System Operation	SLSD Mr.Siva
Land registration administrative processing period /2027/3days	- Exclude holidays for processing period from application to issuance of land. - It is understood that it will take about 14 days from land application to registration during pre-qualification survey in 2019. - It is expected to be available on the 3rd day (one day of reception, one day of processing, and one day of issue) in 2027 when the project was stabilized after completion of 2024.	- Annual financial reports and business statistics of SLD - Direct investigation (survey, interview)	SLSD (Madam Shyamalie Perera)

Indicator / Target year/ Target	Definition and contents	Source	Indicator officer
Annual online service usage / 2027/360,000	- The number of cases in which various services such as information retrieval, application for civil petitions, and confirmation of processing are utilized in the system in which the general public is deployed (annual) - Currently, Sri Lanka does not have any online services available to the public, but after the end of its business in 2024, it has decided to stabilize the country. In 2027, more than 360,000 services (1,000/day x 360 days) are expected to be used annually.	- Annual financial reports and business statistics of SLD - Report on Land Administration and Land Information System Operation	SLSD (Ms Surangani K.L.B.I.)

II. Status Survey and Analysis

1.Generational Information on Sri Lanka

1.1.Generational Information

- Sri Lanka is an island country in the Indian Ocean located southeast of India, with a total area of 65,610km2, which is two-seventh the size of the Korean peninsula, and a population of about 21.69 million people (as of 2018).

- It achieved independence from the British in February 1948 as Ceylon; however, in 1972, its name was changed to Democratic Socialist Republic of Sri Lanka.

- Resident ethnic groups include Sinhalese (75%), Tamils (15%), Moors (9%) and others (1%). Religions practiced in Sri Lanka include Buddhism (70%), Hinduism (12%), Islam (9.7%), Christianity (7.4%), and other/none (0.9%). The official languages are Sinhala and Tamil.

[Figure II-1] Map of Sri Lanka

- As for the economic structure, the biggest industry is service (62.5%), followed by manufacturing (28%) and agriculture (12%)[8] Its tourism industry has become well-developed centering on its clean coastline and tropical climate.

- As a tropical island nation, Sri Lanka is characterized by high-temperature, high-humidity tropical monsoon climate with an average annual temperature range of 26.5℃ ~ 28.5℃. It does not have four distinct seasons, and while it does not receive any snow, frost can be seen at high altitudes in the mountains.

- Farming on fields and paddies occurs in dry areas where there are irrigation canals and rivers. The wet areas inhabited by 60-70% of the population are the main producers of tea, rubber and coconut.

8 National Credit Rating Report Sri Lanka Export-Import Bank Overseas Economic Research Institute (Dec. 2018)

1.2. Political and Social Situations

1.2.1.Political Situation

- The form of government could be described as a semi-presidential system centering on the president, with a cabinet. President Maithripala Sirisena elected in January 2015 and Ranil Wickremesinghe elected in August 2018, came into office as the Prime Minister form a coalition government. However, due to continued discordance, President Sirisena dismissed Prime Minister Wickremesinghe on October 26, 2018 and appointed Mahinda Rajapaksa, a former President, as the new Prime Minister, thereby intensifying political instability. However, a coalition government was formed again with Ranil Wickremesinghe in December in the same year, with the next presidential election scheduled for November 16, 2019.

- Changed the form of government from a self-governing state within the British Common wealth to a republic, abolished the office of Governor-General, and initiated the cabinet system in which it is the Prime Minister with complete administrative power, while the President is the symbolic head of state, by amending the Constitution on May 22, 1972.; Sri Lanka remained in the British Commonwealth as an independent republic.

- Changed the form of government from the cabinet system to the presidential system by amending the Constitution on September 7, 1978.

- Promulgated the draft of the amended Constitution comprised of 16 chapters and 134 articles including the preambles and main texts on May 22, 1972, and adopted the 19th Amendment to the Constitution serving to weaken the authority of the President in 2015.

- The President serves as the head of state, head of the executive branch, and commander-in-chief of the armed forces for a term of 5 years and is elected directly by the people. Sri Lankan citizens over the age of 30 can be a candidate for vote but should be required to nominate a political party.

- As of December 2018, there are 30 government departments, 30 Cabinet ministers, 7 deputy ministers, 17 state ministers, and 3 non-Cabinet ministers. Their number, jurisdiction and scope of duties may be adjusted by the President anytime.

- The Parliament of Sri Lanka is a unicameral 225-member legislature comprised of 196 members elected directly by the people and 29 appointed according to the proportional representation system. The parliament building is located in Sri Jayawardenapura Kotte, the administrative capital of Sri Lanka, which is east of Colombo.

- Political parties can be formed freely, and mergers and dissolutions of parties are frequent. As of January 2017, sixty-four political parties are registered, with the main parties being the UNP and SLFP which have been alternating as the ruling party since Sri Lanka gained independence.

1.2.2. Social Situation

- Although the Human Development Index[9] of Sri Lanka is better than that of its neighboring countries, its Global Competitiveness Index is on the lower end. To be more specific, Sri Lanka ranked 76th out of 189 countries in the HDI rankings reported by the United Nations Development Program (UNDP) as of 2017, and it was ranked higher than other countries located in Southwest Asia (India: 130th; Bangladesh: 136th; Pakistan: 150th).

- Meanwhile, according to a Research conducted by World Economic Forum (WEF) for the 2017-2018, Sri Lanka was ranked among the lower position in labor market efficiency (131st) and technological readiness (106th), and Macroeconomic Environment (94th) declined from previous years, caused by high National Debt Problem (79.3% of GDP in 2017).

- And also lack of its infrastructure had been a reason to be ranked at 85th[10] out of 137 Countries in Global Competitiveness Index, and this was lower than the previous year (71st in 2016).

- The civil war between the Hindu Tamils, a minority group in Sri Lanka, and the Buddhist Sinhalese, making up the majority, was triggered in July 1983 by the killing of thirteen men from the government forces by the separatists among the Tamils (Liberation Tigers of Tamil Eelam, LTTE). The civil war was brought to an end in May 2009, when the massive mop-up operations against the successful sweep of the Tamil rebels ended in success, and the national state of emergency was lifted in August 2011.

- The President Maitripala Sirisena's administration has been striving to promote reconciliation and integration among different ethnic groups by preparing a bill in August 2016 for conducting an investigation into war crimes including the infringement of human rights against the Tamils during the civil war.

- Among the countries in Southwest Asia, Sri Lanka has a high proportion of low-income households, and according to the results of a survey on household income and consumption reported by the Department of Census and Statistics (DCS) of Sri Lanka, the Gini coefficient for the year 2016 was 0.45, a slight improvement from 0.48 three years prior. However, the disparity between the urban and rural areas is still large, and social discontent in Northern, Eastern, Uva and southern Central provinces where the low-income class is concentrated may lead to dissatisfaction with the current government administration.

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9 A measure of the average achievement in aspects of human development including level of education, GDP, life expectancy, etc.

10 Rankings of nearby countries in Southwest Asia: India (40th), Bangladesh (99th) and Pakistan (115th)

1.3.Economic Situation

1.3.1.Overview

- With the near-three-decade-long civil war ending in 2009, there has been growing anticipation for economic growth, an increase in development projects, and a high growth rate of over 7%. However, due to having poor manufacturing infrastructure, the increase in demand resulting from such economic growth actually led to increased demand for imports and therefore trade deficits.

[Table Ⅱ-38] - Economic Situation in Sri Lanka

GDP	USD 88.9 B	Export/Import	Export: USD 12,611 M Import: USD 24,217 M
GDP per capita	USD 4,102	Economic structure	Service 62.5%, Manufacturing 29.7%, Agriculture 7.8%
GDP growth rate	3.2%	International credit rating	OECD 6 Class

Source: Annual Report of the Central Bank of Sri Lanka (2018)

1.3.2.Trends by Sector

- Agriculture
  - Sri Lanka is one of the world's largest tea producers. Tea accounts for about 12% of Sri Lanka's exports, with the total output in 2017 recording 307,080 MT, up 5.03% year-on-year, and tea export in the same year recording 288,984 MT, up 7.37% year-on-year (94.10% of the total output gets exported).
  - To cope with the global food crisis, Sri Lanka is endeavoring to become self-sufficient in growing edible crops, and from 2011, it has been focusing on fostering cinnamon plantations, with the aim of nurturing it into the second biggest agricultural export following tea.

- Fisheries
  - Fisheries contributes 1.3% to GDP, with the offshore fisheries businesses near Sri Lanka rather than aquaculture accounting for the majority of its production.
  - Most of the seafood caught or grown in Sri Lanka is exported. Seafood exports to EU decreased by approx. 75% in 2015, resulting in a 35.5% YOY decrease in total seafood exports, but it has been on the rise again since 2016, with USD 266 million in seafood exports, which was a 10.5% YOY increase, recorded in 2018.[11]

11 Annual Report of the Central Bank of Sri Lanka (2018)

❍ Manufacturing

– Sri Lanka's secondary industry is divided into mining, manufacturing, construction, and public utilities (electricity, gas, and water) accounting for 26.8% of GDP. Manufacturing is the largest sector among them and it contributes 15.7% to GDP.

– The main manufacturing industries in Sri Lanka are textiles, clothing, leather products, food, beverages, tobacco, petroleum, rubber and plastics, and nonferrous metals.

– The new government administration that took office in 2015 was re-approved by the United States for GSP+ benefits and regained the GSP+ status from the EU in May 2017. Based on this, it is expected that there will be a boom of clothing manufacture for the time being.

– In order to foster manufacturing for exports, building infrastructure such as roads, ports, and telecommunications systems will be key.

❍ Tourism

– Sri Lanka has rich tourism resources, being an island country that is surrounded by the sea on all four sides. This is why tourism industry contributes 14.5% to GDP, which is quite high, and there is a strong interest in the tourism industry.

– There has been a rapid increase in foreign tourists thanks to diversification of tourism products, increased investment, development of tourist attractions aside from historic sites, successful tourism promotion campaigns, etc.

– The number of tourists from Europe is especially high at 51% of the total number of tourists, followed by tourists from the Asia-Pacific region (24%). The number of tourists from Korea has more than doubled since the opening of a direct flight route to Sri Lanka in 2013 and it reached 16,000 in 2016.

– The labor crisis in the labor-intensive production industry has been intensifying as the labor force has been moving from the manufacturing sector to the service sector due to the boom of hotel, restaurant and tourism service industries.

❍ IT

– The government of Sri Lanka is actively fostering the IT industry, a high value added industry, and expanding the Internet base for the purpose of diversifying its export industries from the current textile industry.

– The Internet penetration rate, which has been steadily rising year after year, is currently around 30%.

– The Internet-related industry is in its infancy, and there are no portal sites in Sri Lanka at present. So, people mainly use Google (www.google.lk) for online search.

1.4. Other Information

1.4.1. Tax System

❍ The Foreign Company should be a subject to direct Taxation. as per Sri Lanka Law(Foreign Exchange Regulations Gazette 1 of 2017, Permanent establishment), if the Headquarters or registered branch office was consolidated/located in Sri Lanka and occurred management and Control.

❍ Tax administration is supervised by the Inland Revenue Department, which is operated by the Ministry of Finance. Taxes that are applicable to foreign companies include corporate income tax, personal income tax, value added tax, withholding tax, national building tax, duties and tariffs, and other charges.

1) Corporate Income Tax

❍ All types of corporations engaging in business activities in Sri Lanka are taxed at the normal tax rate of 28% (adjusted from 35% to 28%, as of April 2011), except in cases of manufacture and distribution of alcohol and tobacco (40%), in principle. However, depending on the investment amount, BOI companies may be subject to 100% tax exemption (Tax Holiday) or a 10% or 15% concessionary rate, based on the result of negotiations with the Board of Investment of Sri Lanka (BOI).

❍ Even in the case of regular companies, if tourism, export and/or taxable income does not exceed LKR 5 million (approx. USD 46,000), a 12% concessionary rate is applied. Originally, the concessionary rate is restricted to companies with foreign ownership not exceeding 25%, but companies from Korea are to be treated the same as companies with a foreign ownership of less than 25% under the tax treaty signed to avoid double taxation.

❍ Corporate taxes are charged in accordance with the conditions specified in the Tax Act and accounting principles, and deductions are applied to related domestic and overseas project costs.

❍ A corporate tax rate of 10-12% is applied unless otherwise specified in the Tax Act for the business type in question.

[Table Ⅱ-2] Corporate Income Tax Rates in Sri Lanka

Description	Tax rate
- Standard Rate	
Taxable income of a company (other than companies taxed at special rates)	28%
- Special Rates	
Small and Medium Enterprises	14%
Company predominantly conducting business of exporting goods & services	14%
Company predominantly conducting an agricultural business	14%

Description	Tax rate
Company predominantly providing educational services	14%
Company predominantly engaged in an undertaking for the promotion of tourism	14%
Company predominantly providing information technology services	14%
Income from a business consisting of betting and gaming, liquor and tobacco	40%
Gains from the realization of investment asset	10%
Remittance tax on non-resident companies	14%
Relocating International headquarters in Sri Lanka	0% (for 3 years)
- Tax Rate for Partnerships	
Gains from realization of investment asset	10%
- Tax Rates for Trusts	
Taxable income of a trust (other than gain on realization of investment asset)	24%
Gains from realization of investment asset	10%
- Tax Rates for Unit Trusts or Mutual Funds	
Taxable income of unit trusts or mutual funds (other than gain on realization of investment asset)	28%
Gains from realization of investment asset	10%
- Tax Rates for Charitable Institutions	
Taxable income of charitable institutions (other than gain on realization of investment asset)	14%
Gains from realization of investment asset	10%
- Tax Rates for Non-Governmental Organizations	
Taxable income of a non-governmental organization (other than gain on realization of investment asset)	28%
Gains from realization of investment asset	10%
- Tax Rates for Employee Trust Funds, Provident or Pension Funds and Termination Funds	
Taxable income of employee trust funds, provident or pension funds and termination funds	14%

2) Personal Income Tax

❍ Personal income tax rates are differentially applied depending on the amount of annual income of the taxpayer.

❍ Taxable income is classified as earned income, property income and material gains.

❍ According to the Tax Act of Sri Lanka, international tax treaties and relief treaties signed by the Sri Lankan government take precedence.

[Table II-3] Personal Income Tax Rates in Sri Lanka

Tax Rates for Resident and Non-Resident Individuals	
- Personal relief for residents/non-resident citizens of Sri Lanka is Rs. 500,000/- - Additional relief of Rs. 700,000 is available on employment income (maximum tax rate applicable for employment income is 24%)	
Description	Tax Rate
Taxable Income	
First Rs 600,000/-	4%
Next Rs 600,000/-	8%
Next Rs 600,000/-	12%
Next Rs 600,000/-	16%
Next Rs 600,000/-	20%
On the balance	24%
- Gains from realization of investment assets is taxed at the rate of 10%. - Income from a business consisting of betting and gaming, liquor or tobacco is taxed at the rate of 40%.	

[Table II-4] Tax on Terminal Benefits from Employment

Description	Tax Rate
- Paid under uniformly applicable scheme	
On the first Rs. 5 M of the aggregate sum where the period of services or contribution is not less than 20 years	Exemption
On the first Rs. 2 M of the aggregate sum where the period of services or contribution is less than 20 years	Exemption
On the next Rs 1,000,000	5%
On the balance	10%
- Paid under non-uniformly applicable basis	
Compensation for loss of office or employment (normal rates - subject to maximum rate)	24%

3) Value Added Tax

❍ Value added tax (VAT), which used to be charged at a rate of 12% on sales, is now charged at a rate of 15% after the new rate was passed by the Parliament on May 2, 2016.

❍ The VAT rate applied to companies providing IT services is 14%.

4) Special Consumption Tax

❍ The Export Development Board (EDB), called CESS, charges a tax rate of between 10% and 35% on various imports that are unnecessary or may reduce the competitiveness of the local industry.

❍ Due to the 2017 and 2018, EDB charges on 350 items were removed to rationalize the tariff structure on government budgets

5) National Building Tax (NBT)

❍ 2.03% of turnover is charged as national building tax (NBT), which has been imposed on annual turnover since 2015. NBT collected per quarter has increased from LKR 3 million to LKR 3.75 million. Machinery, equipment and parts imported by the Sri Lanka Ports Authority to be used exclusively at certain ports are exempted from the NBT. The maximum discount on NBT imposed on sample imports has been increased from LKR 25,000 to LKR 50,000.

1.4.2.Duties and Customs Clearance

1) Duties & Taxes

❍ Sri Lanka's most-favored nation (MFN) applied tariff rate for agricultural products averaged 26.9 percent, and its MFN applied tariff for non-agricultural goods averaged 6.3 percent in 2017.

❍ There are currently three import tariff bands: 0, 15, and 30 percent. Generally, raw materials are at zero percent, intermediate goods are at 15 percent, and finished goods are at 30 percent.

❍ The 2017 and 2018 government budgets removed certain supplementary taxes on several items. However, supplementary taxes still continue on a wide range of items sharply raising their prices

2) Procedure by Customs Clearance Type

❍ The procedures of customs clearance is divided into taxable imports and duty free goods. And the procedure for duty-free is further divided into direct import and Temporary Importation for Export Processing Scheme (TIEP).

❍ custom Clearance for Taxable Import

❍ To register as an import and/or export company, one must first register one's business with the Inland Revenue Department (IRD) to obtain a Taxpayer Identification Number (TIN) and then register as an import and/or export company with Sri Lanka Customs.

❍ To obtain a TIN, one must visit the IRD and fill out the required form in person or download the registration form from the IRD website (http://www.ird.gov.lk) and submit it online after filling it out.

❍ The departments responsible for import-related affairs under Sri Lanka Customs are divided into the one in charge of customs clearance of ocean cargo received at the Port of Colombo and the one in charge of air cargo received at Bandaranaike International Airport.

❍ In order to process import documents, a signed and Completed Customs Declaration (CUSDEC) must be submitted to Customs along with other import-related documents.

❍ Depending on the type of imported goods, a permit, certificate, etc. may be required before the submission of CUSDEC and Sri Lanka Customs may require approval for import from the relevant government agencies (e.g. Import and Export Control Department, Sri Lanka Standard Institution, Health Department, etc.) prior to the release of certain types of imported goods.

❍ For example, in order to import tea into Sri Lanka, it is required to firstly submit the documents required by the Ceylon Tea Board and obtain approval, and in the case of used cars, an import license must be acquired first.

❍ Customs clearance should be done by licensed customs agent in the Shipping Company registered at the customs office, not the individual or the general company.

❍ Custom Clearance for duty free

❍ Direct-import refers to a type of business importation involving a major retailer (e.g. Wal-Mart) and an overseas manufacturer. A retailer typically purchases products designed by local companies that can be manufactured overseas. In a direct-import program, the retailer bypasses the local supplier (colloquial middle-man) and buys the final product directly from the manufacturer, possibly saving in added costs. This type of business is fairly recent and follows the trends of the global economy. (Source : Sri Lanka Customs Website.)

❍ Temporary Importation for Export Processing (TIEP) Scheme allows manufacturers who manufacture goods for export or indirect export to import inputs without payment of Fiscal Levies. By relieving manufacturers cum exporters from domestic taxes it is expected to enhance the competitiveness of export production and encourage expansion of production capacities and exports.

❍ There are two main divisions in TIEP scheme, i.e. TIEP-1 and TIEP-4. The importation of inputs such as raw-materials, components, parts and packaging materials comes under TIEP-1 and importation of capital goods, appliances and spare parts comes under TIEP-4. (Source : Sri Lanka Customs Website.)

❍ Transit cargo (i.e. cargo imported and re-exported under the control of Customs in a bonded area) is not subject to any customs duties and taxes nor any pre-shipment inspection process.

❍ Import documents vary from case to case, but they typically include Delivery Order, Bill of Lading (B/L), Exchange Documents, Invoice, Packing List(s), and Certificate of Origin.

❍ The International Article Number (EAN) System is an international trade term and an internationally recognized numbering system with which a total of 101 organizations around the world have registered. In Sri Lanka, EAN Sri Lanka assigns an EAN Bar Code to products. On the other hand, Uniform Product Code (UPC) is a special code system that is still in use in some parts of the United States and Canada, and if it is needed for trade purposes, one can request EAN Sri Lanka for one.

3) Sri Lankan Customs Procedures for Imported Goods

❍ Duties imposed on imported goods range from 0% to 60% depending on the product category, and the rate for each product category is changed frequently by Presidential Decree.

❍ For the Automated System for Customs Data (ASYCUDA) and Customs Declaration (CUSDEC), Warranty Copy, Delivery Copy, Exchange Copy, and Party's Copy must be prepared. CUSDEC can be processed at Customs Long Room (Katunayake) or import offices with DTI facilities.

[Table Ⅱ-5] Required Documents for Customs Clearance of Imported Goods

Category	Required Documents or Special Approval
Common	- Bank stamped invoices and packing list - Goods arrival notice / Air Way Bill / House Way Bill
Phones and accessories	- TRC (Telecommunication Regulatory Commission) - ICL ((Import Control License)
Medicines and medical equipment	- NMRA (National Medicines Regulatory Authority) - ICL (Import Control License)
Rifles, guns and other weapons	- Ministry of Defence approval - ICL (Import Control License
Live plants	- Plant quarantine
Vegetables and fruits	- IFIU (Imported Food Inspection Unit)
Live animals	- Animal quarantine - ICL (Import Control License)
All food items	- IFIU (Imported Food Inspection Unit)
Cosmetics	- CDDA (Cosmetics Drugs Devices Authority)
Boat Engines (more than 25 HP)/ Motor cycle engines (more than 250cc)	- Ministry of Defence - ICL (Import Control License)

4) Matters Requiring Attention in Relation to Customs Clearance

❍ It is especially convenient for BOI-managed companies that have moved into any of the industrial complexes run by the BOI, as customs inspection is performed in the presence of the customs staff after the container is brought into their resident industrial complex.

❍ Usually, it is possible to complete the customs clearance process for raw and subsidiary materials and put them into the production process in about two to three days from the time at which the cargo arrives at the port. On the other hand, local investment companies that have not moved into an industrial complex spend more time and money than those that have moved into an industrial complex because their containers must be transported from the port to a designated area for a complete inspection, rather than being transported to their factory.

❍ Inefficient administrative practices are widespread in Sri Lanka, and customs clearance is no exception. Due to such inefficient practices that are difficult to predict, there are concerns that unexpected expenses will incur. If goods are received via Express Mail Service (EMS), the local EMS provider is supposed to deliver the package to the recipient's address, in principle. However, if the goods are rather large, the recipient must visit the EMS pickup center for customs clearance after a simple inspection by a customs officer (and payment of duties and taxes if necessary) in order to pick up the goods.

1.4.3.Transportation

1) Road Transport

❍ Transportation is Sri Lanka is mainly based on the road network centering on Colombo, and road transport accounts for 93% of all land transport[12]

❍ Recent investment has mainly been concentrated on highways, but the number of roads is still inadequate.

❍ Sri Lanka has an extensive road network to provide seamless connections between residential areas and areas of economic activity. Road density is currently 5.19km per 1,000 people, which is the highest in Southwest Asia considering that it is 2.00km and 1,69km er 1,000 people in Bangladesh and Pakistan.

❍ The current road network consists of approximately 12,000km of national highways, 152km of expressways, 15,500km of provincial roads, 65,000 km of local authority roads and 24,000km of roads owned or controlled by non-road agencies for irrigation, wildlife conservation or other purposes, etc.13

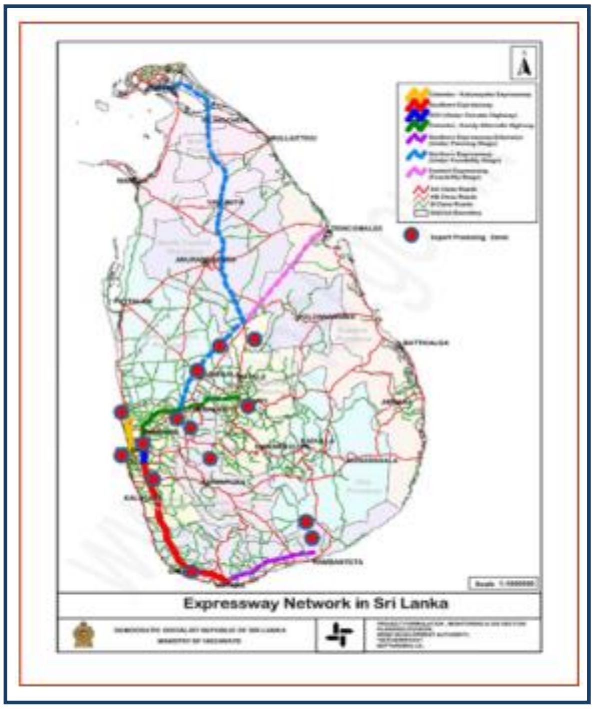
❍ 100% of national highways, 67% of provincial roads, and 13% of local authority roads are paved.

❍ In recent years, expressways and national highways – as well as provincial, district, and rural roads – have been built or up\-graded with financial support from the Asian Development Bank.

❍ The National Road Master Plan 2008–2017, developed by the Ministry of Highways and Road Development, aims to ensure that the road network will be planned, maintained, constructed and developed to enhance national integration and economic growth.

12 Asian Development Bank (2017). Sri Lanka: Railway Master Plan, project data sheet

13 Sri Lanka, Ministry of Highways and Road Development (2007). National Road Master Plan 2007−2017: Executive Summary and the Investment Pla



[Figure II-2] Expressway Network in Sri Lanka

2) Rail Transport

❍ The rail network connects major cities with Colombo and is comprised of 1,508km of tracks.

❍ Railway services, which are primarily a legacy of British colonial rule, are typically intended for passenger transportation and only hold a 1% share of the freight market.[14]

❍ The government plans to increase the rail transport's share of the freight market by 2020 through the Public Investment Program 2017-2020.

3) Port Facilities

❍ In Sri Lanka, there are four deep-sea ports: the Port of Colombo, Port of Hambantota, Port of Trincomalee and Port o Galle.

❍ The port system is under of the control of the Sri Lanka Port Authority (SLPA). The main port services are container handling, transshipment and cargo.

❍ Container handling in Colombo Port is increasing year to year, main\-ly supported by increased operations in the Colombo International Container Terminal and South Asia Gateway Terminal.

14 Asian Development Bank (2017). Sri Lanka: Railway Master Plan, project data shee

- ❍ The total container handled increased by 10.6% from 5.2 million TEUs in 2015 to 5.7 million TEUs in 2016.

- ❍ The performance of the Port of Hambantota, on the other hand, weakened due to a lack of industries in the hinterlands.

- ❍ Activities at this port are primarily vehicular transportation, roll-on/roll-off operations, and bulk and gas transportation.

- ❍ The Port of Trincomalee, located on eastern province area, provides passenger ship services and caters to bulk cargo and port-related industrial activities including heavy industries, tourism, agriculture, etc.

- ❍ The Port of Galle may currently be small in size, but SLPA plans to develop a full-scale yacht marina as well as facilities for handling cargo of international vessels.

4) Airport Facilities and Air Transport

- ❍ Sri Lanka's aviation network is comprised of 17 airports including Bandaranaike International Airport (BIA), Ratmalana International Airport, and Mattala Rajapaksa International Airport. Most international flights occur via BIA, located 35km north of the capital.

- ❍ Sri Lanka's aviation network is built around 17 airports, of which three are international : BIA, Ratmalana Airport and Mattala Rajapaksa International Airport.

- ❍ Most international traffic is routed through BIA, located 35 km north of the capital. All three airports have cargo handling facilities

- ❍ All three international airports have cargo handling facilities and are managed by the Airport and Aviation Services (Sri Lanka) Ltd.

- ❍ The total amount of cargo handled by BIA increased by 18.1% in 2016. Katunayake EPZ and Colombo are connected well via the Colombo–Katunayake Expressway.

- ❍ Mattala Rajapaksa International Airport handled 916 aircraft movements in 2016 compared to 884 aircraft movements handled in the previous year.

- ❍ To link logistics activities, minimize congestion and maximize efficiency, a logistics corridor concept is currently being developed to accommodate trans-shipment facilities, storage, collection and local-level distribution of cargo.

- ❍ The Ministry of Megapolis and Western Development (MoMWD) proposed, through the Megapolis project, to develop logistics services focusing on four major corridors : Colombo–Hambantota, Colombo–Trincomalee, Colombo–Kandy and Colombo–Jaffna, and within Colombo Metropolitan Region.

❍ The aim is to develop clusters that can accommodate shipping facilities, storage, collection and regional-level distribution of cargo.

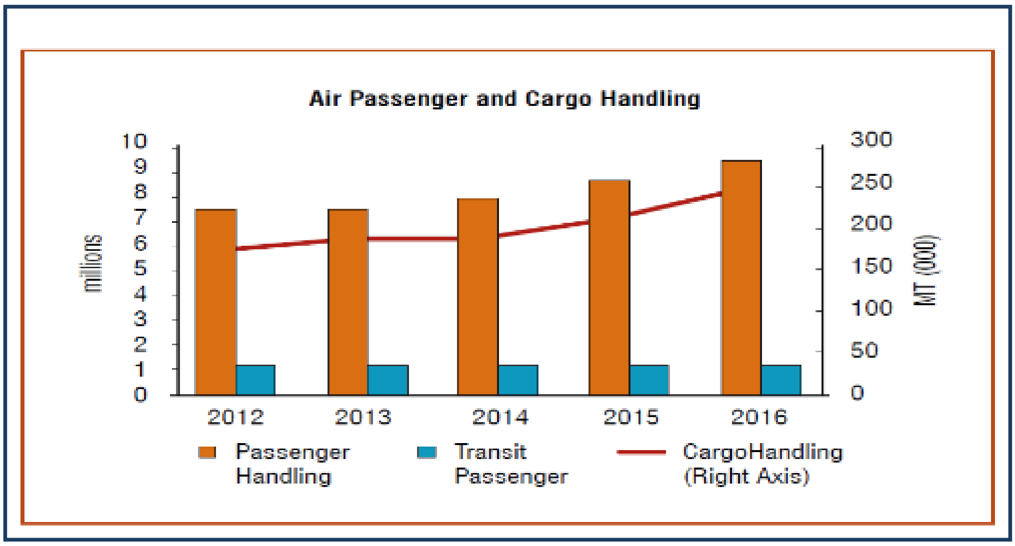
❍ Plus, rail and expressway networks will be established to minimize congestion and maximize the efficiency of logistics services.

❍ A number of export processing zones (EPZs) have been successfully established to eliminate redundant processing and shorten the processing time for sea-to-air transport (and vice versa) as a means to maximize the benefits of transportation, logistics and trading.

❍ The first EPZ in Sri Lanka began its operation in 1978 in Katunayake, and there are now 14 EPZs nationwide.

❍ EPZs are managed by the BOI, which provides support in each stage of the investment process. EPZs are intended to attract foreign direct investment (FDI), promote economic and industrial development, and promote exports, foreign exchange and employment through various financial and non-financial incentives offered to investors.

❍ According to related laws, export items are exempt from import duties on capital goods and raw materials and foreign exchange management, and incentives include tax holidays and tax concessions.



[Figure II-3] Amount of Air Passengers and Cargo Handling

2. National Development Plan and ICT Status

2.1. National Development Plan

2.1.1. Vision 2025

❍ Sri Lanka has established Vision 2025, a long-term development plan spanning ten years from 2015 marking the 70th anniversary of independence to 2025. The aim of the plan is to transform Sri Lanka into the hub of the Indian Ocean and to build a knowledge-based and competitive social market economy. Specific goals and targets include attaining GDP per capita of USD 5,000, creating one million jobs, attracting FDI of USD 5 billion per year, and increasing annual exports to USD 20 billion.

❍ The Sri Lankan government has divided the main obstacles hindering its economic growth into four categories: economic growth structure centering on introduction of foreign capital, low export performance, increased public debt, and regulations. In order to address these issues, economic development is being pursued based on nine axes.

[Table Ⅱ-6] Vision 2025: Main Approaches for Economic Development of Sri Lanka

Area	Sub-area	Description
Strengthening the macroeconomic framework	Financial soundness	- Restore financial soundness - Achieve financial integration based on tax revenue - Ensure effective management of tax revenue - Strengthen administrative capacity - Streamline government spending - Change the economic growth structure - Increase public investment programs (PIP)
	Monetary and exchange rate policies	- Introduce measures for price stability - Improve exchange rate policy
Strengthening the growth framework	Promote and attract investment	- Promote investment and attract investors by reducing policy uncertainties - Reform the investment incentive policy - Support SMEs
	Export-oriented trade policy	- Improve export strategies - Implement a trade liberalization program - Develop a trade adjustment program - Improve export competitiveness - Enhance access to trade finance - Encourage diversification of exports - Nurture Sri Lanka as a global logistics hub
	Development of tourism industry	- Establish strategies to develop the potential of the tourism industry - Introduce conducive institutional framework for SMEs in the tourism industry to flourish - Liberalize access to sea and air services - Develop tourist attractions
Reforms in land, labor	Land policy	- Create a dynamic land market

Area	Sub-area	Description
and capital markets	reform	- Align land policy with the national development plan - Ensure scientific land management
	Labor market reform	- Encourage women to partake in the labor market - Improve labor productivity - Encourage overseas migration of the labor force - Strengthen cooperation with overseas Sri Lankans - Support the vulnerably employed - Promote employee-employer relations
	Capital market reform	- Encourage private sector investments - Improve the capital market regulatory environment - Develop the Colombo International Financial Centre (CIFC) and other related services
Economic and social infrastructure	Education and technical development	- Provide 13 years of public education - Increase access to higher education - Expand opportunities for vocational training with private sector support - Restructure curricula for youth - Concentrate on skills development programs for job creation
	Improvement of health care	- Strengthen the primary health care delivery system - Support programs for eradicating chronic kidney disease - Review alcohol taxation policies - Lay the foundation for electronic medical information management system - Expand pre-hospital emergency care services
	Connection to social infrastructure development plan	- Increase investment in logistics, with a focus on infrastructure - Establish economic corridors - Secure drinking water and sanitation facilities - Encourage vertical housing projects - Improve the public transportation system - Establish a master plan for transportation and perform flood mitigation projects
Technology and digitalization	Technical development policy and strategies	- Encourage the transfer of cutting-edge technologies from overseas - Promote private sector investment in digital technology - Incentivize private sector investment in the ICT industry - Integrated ICT literacy into education programs - Expand Internet access - Create digital IDs - Digitalize government operations - Strengthen ICT-based marketing interfaces - Encourage innovations in mobile payment systems and P2P lending platforms - Strengthen the functions of the National Intellectual Property Office - Prepare the institutional framework for electronic transactions

Area	Sub-area	Description
Social safety nets	Social security programs	- Establish an integrated, efficient social protection system - Introduce a contributory pension benefit scheme - Expand the scope of the Samurdhi (poverty eradication) program - Improve access to public services, education, and employment opportunities
Agriculture and sustainable development	Strengthening agricultural productivity	- Promote efficiency in agricultural markets - Promote private sector participation - Conduct a project to modernize the agriculture sector - Encourage the plantation sector to modernize - Support small-scale farmers - Promote investment in the livestock sector - Promote investment in the fisheries sector - Implement the Smallholder Agribusiness Partnership (SAP) project - Encourage fertilizer uses
	Balanced development across all regions	- Establish a new development bank - Undertake key development projects - Implement a comprehensive District Development Plan - Initiate development projects in Uva Province - Establish regional technology centers - Implement strategies for financial inclusion
	Improvement of disaster/crisis management	- Implement measures to improve disaster management - Take measures to reduce greenhouse gas emissions - Development an eco-friendly transport system - Introduce a green financing strategy - Phase-out single-use polythene
	Energy supply	- Establish a long-term energy (electricity) generation plan - Develop sustainable clean energy sources - Devise an energy pricing formula - Ensure efficient energy demand management - Develop the petroleum industry
Governance and accountability	Governance reform	- Strength governance policies - Guarantee the rights of citizens - Strength citizens' right to information - Implement the Grama Rajya (GR) concept
Strengthening coordination and monitoring implementation	Monitoring and coordination for effective implementation	- Implement a consistent and predictable economic policy framework - Strengthen the capacity for monitoring and evaluation - Implement digitalization to support monitoring

2.1.2. e-Government Development Plan

❍ The government of Sri Lanka is encouraging the introduction of information technology and e-Government projects to build an information society. Such projects are mainly managed by ICTA[15] with plans to provide bidirectional services to government departments and the public by 2020.

❍ Sri Lanka's first-ever e-Government policy was approved at a Cabinet meeting in December 2009 and adopted and implemented by all government agencies between 2010 and 2012.

❍ The Sri Lankan government conducted an annual review of the implementation of the e-Government policy for four years from 2010 to 2013, and the results showed that the policy compliance rate was lower than what had been targeted. Reasons for the low compliance rate were identified as follows:

- The e-Government policy included highly complex policy requirements;
- Extensive scope: e-Government policy presented 29 statements and 177 policy guidelines and did not take into account the varying levels e-Government maturity of each government agency;
- Responsibilities in regard to policy enforcement not clearly identified;
- The Chief Innovation Officers (CIOs) overseeing policy implementation lacked a clear idea of how to proceed and lacked the authority for implementation;
- The reason the government was implementing this policy was unclear (unclear policy objectives).

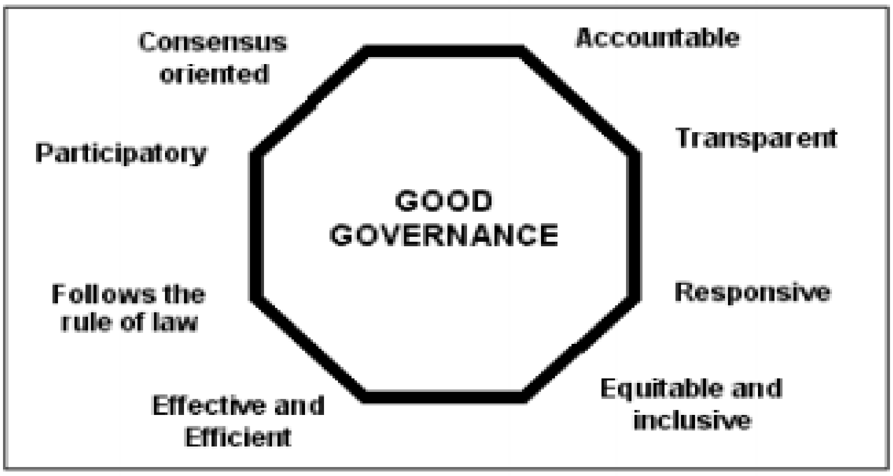
❍ In order to establish a feasible e-government policy, the Chairman of the ICTA drafted a policy amendment and appointed an e-Government Policy Review committee composed of members of Sri Lankan government agencies and those from nations with advanced e-Government systems.

❍ The e-Government policy is being implemented under the policy goals revised by ICTA in January 2014 under the vision of applying ICT to raise the efficiency and effectiveness of the government, improve access to government services and establish a citizen-centered government, and the policies and procedures are to be followed by all government organizations incl. ministries, government departments, provincial councils, district secretariats, local authorities, government corporations, statutory bodies, and companies fully owned by the government.

❍ e-Government Development Plan is continually updated based on the changes in the implementation environment, technology and business processes, and executed under the following eight principles:

15 ICTA: Information & Communication Technology Agency (executive organization formed for the purpose of supporting the establishment and execution of e-Government policies in Sri Lanka

Principles	Effective and Efficient; Responsive; Equitable and Inclusive; Accountable; Transparent; Participating; Consensus-oriented; Following the rule of law



Source: eGovernment policies and Procedures

[Figure Ⅱ-4] 8 Principles of e-Government of Sri Lanka

❍ ICTA has set forth the following ten policy objectives to implement the e-Government policy:

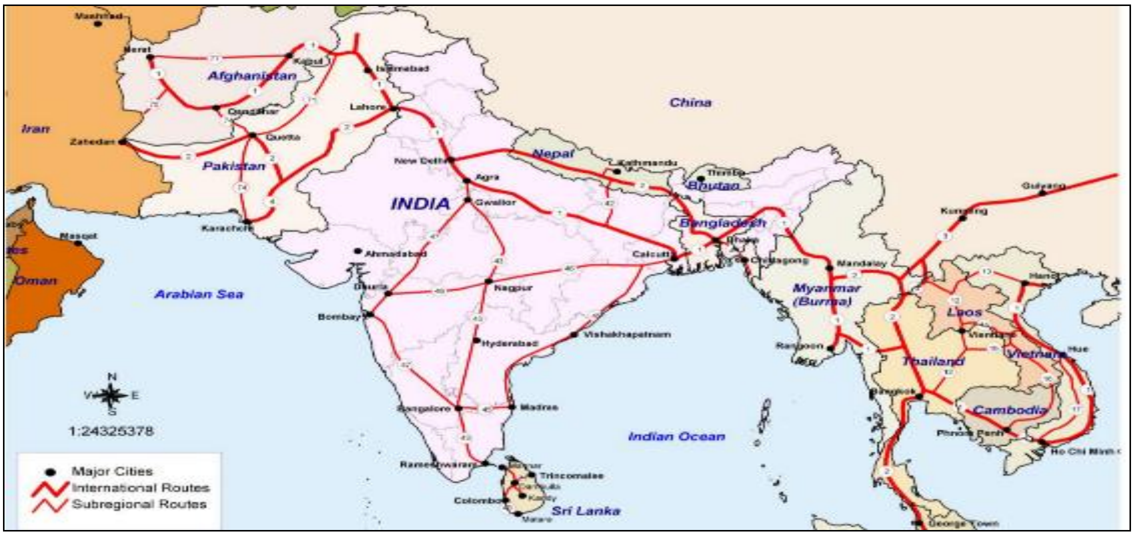
- Make government information available and accessible electronically to citizens through multiple channels
- Make government services electronically available and accessible to all citizens via multiple channels in a citizen friendly manner
- Improve/Re-engineer government processes to be citizen centric
- Use e-Government to eliminate duplication in ICT Infrastructure, information collection, government processes and ICT solutions within and across government organizations
- Use of ICT to achieve, measure, monitor and publish defined service levels for all government services
- Address the requirements/needs of marginalized communities through ICT
- Implement processes and systems in government organizations to be highly responsive and interactive through the use of ICT
- Enable citizen engagement through electronic means for consensus driven, public policy and decision making process wherever authorized
- Strengthen rule of law through the use of ICT
- Establish and implement of a proper enabling operational framework for successful e-Governance

2.1.3.Land Development Plan

– The National Physical Plan has been implemented by the National Physical Planning Department (NPPD) in accordance with the Town and Country Planning Act No. 49 since 2000. There exists the Technical Advisory Committee (TAC) comprised of experts from departments concerned in land development technology; the Inter-Ministerial Secretary Coordinating Committee (IMCC) consisting of the chief secretaries of the nine provincial councils concerned in the actual plan and project and the secretary of each ministry; and the National Physical Planning Council (NPPC) comprised of ministers and chief ministers of the nine provincial councils.

– International Transport and Access

– Plans to build roads and railroads such as the Asian Highway and Trans-Asian Railway to connect Sri Lanka with the South Asian mainland for the purpose of drastically transforming Sri Lanka’s trade and exchange with India and other South Asian neighbors.



[Figure Ⅱ-5] Proposed Link to the Asian Highway

[Table II-7] Trans-Asian Plan Details and Budget

Description	Budget
Ship Transport – upgrade existing port facilities	Rs. 15 billion
Railway Bridge Crossing	Rs. 200 billion
Road/Rail Bridge Linkage	Rs. 400 billion
Tunnel Rail	Rs. 500 billion

– Indian-pacific Sea Route: A plan to achieve a high growth economy by building powerful transportation networks with neighboring island countries and other countries

– International Air Routes: A plan to expand logistics and passenger accessibility by linking Sri Lanka with one or more international hub airports in South Asia

❍ Connection with the International Communications Network

– Sri Lanka has set forth a plan to expand its communications networks by forming an important hub in the optical fiber submarine network. The plan is to improve the telecommunications networks and plan for securing IT infrastructure using global optical fiber submarine networks

❍ Energy and Exploration

– Sri Lanka is expanding its Exclusive Economic Zone and accordingly, it is planning for partnership projects for offshore oil and gas exploration and development.

[Table II-8] Summary of Internationally Linked Development Plans

Development plan	Project	Description	Priority ranking
Transport and Access	Asian Highway	Connection to Southern India	-
	Trans-Asian Railway	Connection to Southern India	-
	Indian-Pacific Sea Routes	New major port facilities at Hambantota	1
		Expand port at Olivil	2
		Expand port at Tricomalee	3
		Expand port at Kankasanthural	4
		Passenger port at Mannar	5
		Improve port at Galle	6
	International Air Routes	New International Airport at Mattale	1
		Expand International Airport at Bandaranaike	2
		New International Airport at Hingurkgoda	3
Connection with International Communications Networks	Optical Fiber Network	Create International Communication Hub	-
Energy and Exploration	Exploration & Development	Encourage Oil & Gas Exploration in the Exclusive Economic Zone	1
		Encourage Private/Partnership exploitation of Energy Resources	1

❍ National Physical Plan

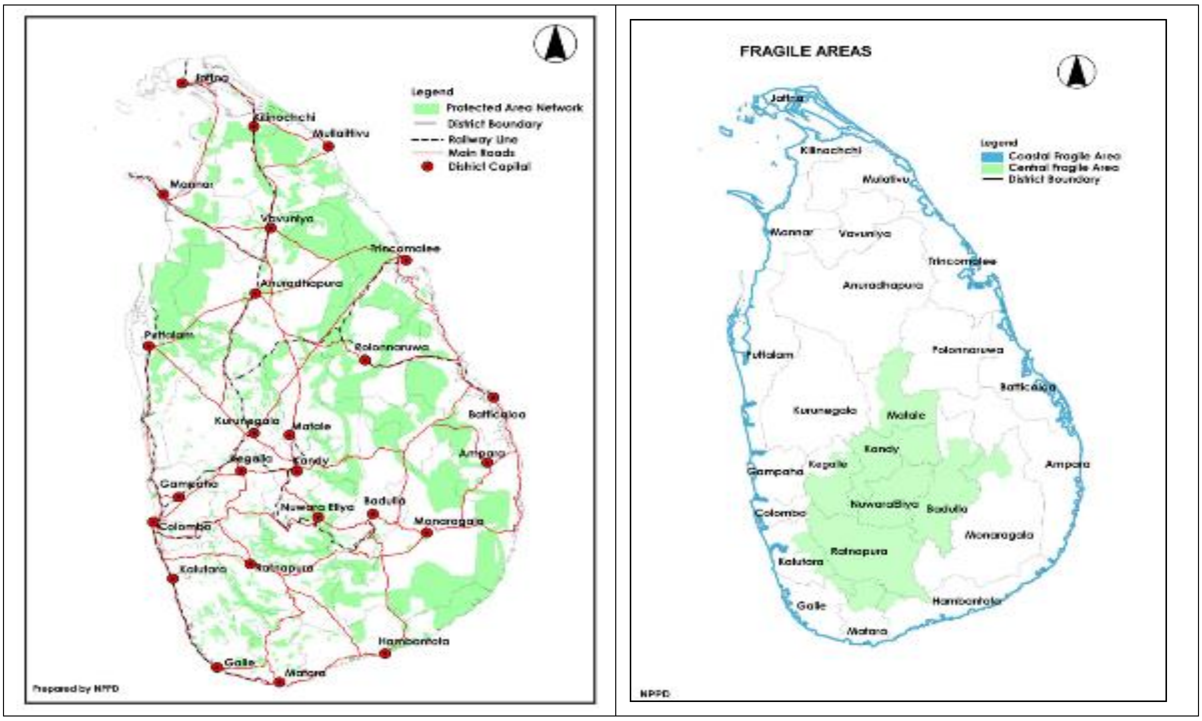
– The population of Sri Lanka is estimated to reach 25 million by 2030. To accommodate the estimate growth, a plan to develop new cities and restrict development in the Protected Area Network (PAN) and the Central Fragile Area (CFA) has been established.

– The PAN includes wildlife reserves and identified corridors; conservation forests; degraded forest areas that will be restored for ecological reasons; areas of archaeological and historical value; areas of natural beauty and natural features of exceptional value; environmentally and hydrologically important wetlands and catchments; corridors identified by the National Physical Planning Department; areas where landslides are likely; unutilized lands in areas of high rainfall intensity, with slopes that have a gradient of over 60 degrees and highly erodible soils; and all natural and man-made water courses, water bodies and their reservations.

– Regulate development in the PAN

– Protect and retain land with environmental values

– Create new cities and settlement areas and encourage an outward movement of population and plantations from the PAN and CFA

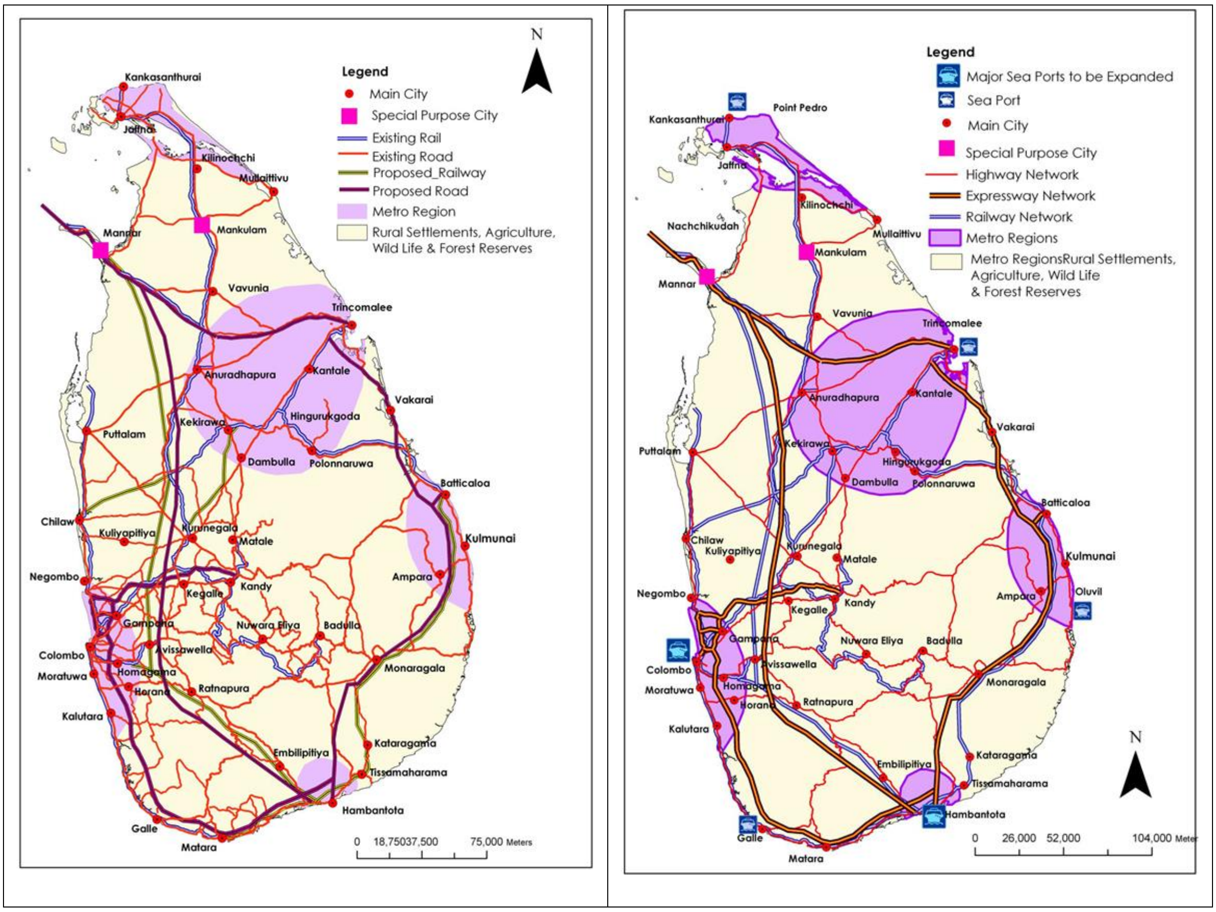


[Figure Ⅱ-6] PAN (Left) and CFA (Right) in Sri Lanka

❍ National Physical Plan for Infrastructure Facilities

- An efficient and developed physical and social infrastructure network across the country is pivotal for creating opportunities for economic growth, poverty eradication and job creation and thereby reducing regional disparity. A network of infrastructure including transport that supports and links cities, towns and villages will create an economic environment that will be able to provide jobs and services to their respective communities.
- Transport is an essential component of economic infrastructure, and by connecting Sri Lanka with other parts of the world and facilitating movement of goods and people within the country, improved access can be provided to the domestic and international markets. Upgrading the transport infrastructure improves access to work, ports and other economic activities and lowers the cost of doing business.
- Despite the continued expansion of infrastructure facilities in Sri Lanka, existing capacity constraints have limited potential economic development. These constraints can be identified across all parts of the infrastructure network including passenger and freight transportation (road, rail, air and sea), water and electricity supply, solid and waste disposal, and telecommunications. A plan for mitigating such constraints is necessary.
- Main details of the plan
  - Maintain and rehabilitate the existing road network and construct regional highways to urban regional centers;
  - Develop bus networks to improve inter-city and intra-city connections;
  - Upgrade and extend the railway network for passenger and freight travel;
  - Develop regional and international ports and support infrastructure to reinforce sea based economic gateways to Sri Lanka;

- Improve domestic and international aviation linkages for passenger transport and expand capacity for air based cargo transport;
- Enhance telecommunications networks;
- Ensure the sustainable management, treatment and disposal of solid waste and sewerage.



[Figure Ⅱ-7] Existing and Proposed Roads/Railway (Left) and Ports (Right)

[Table Ⅱ-9] Summary of National Physical Plan

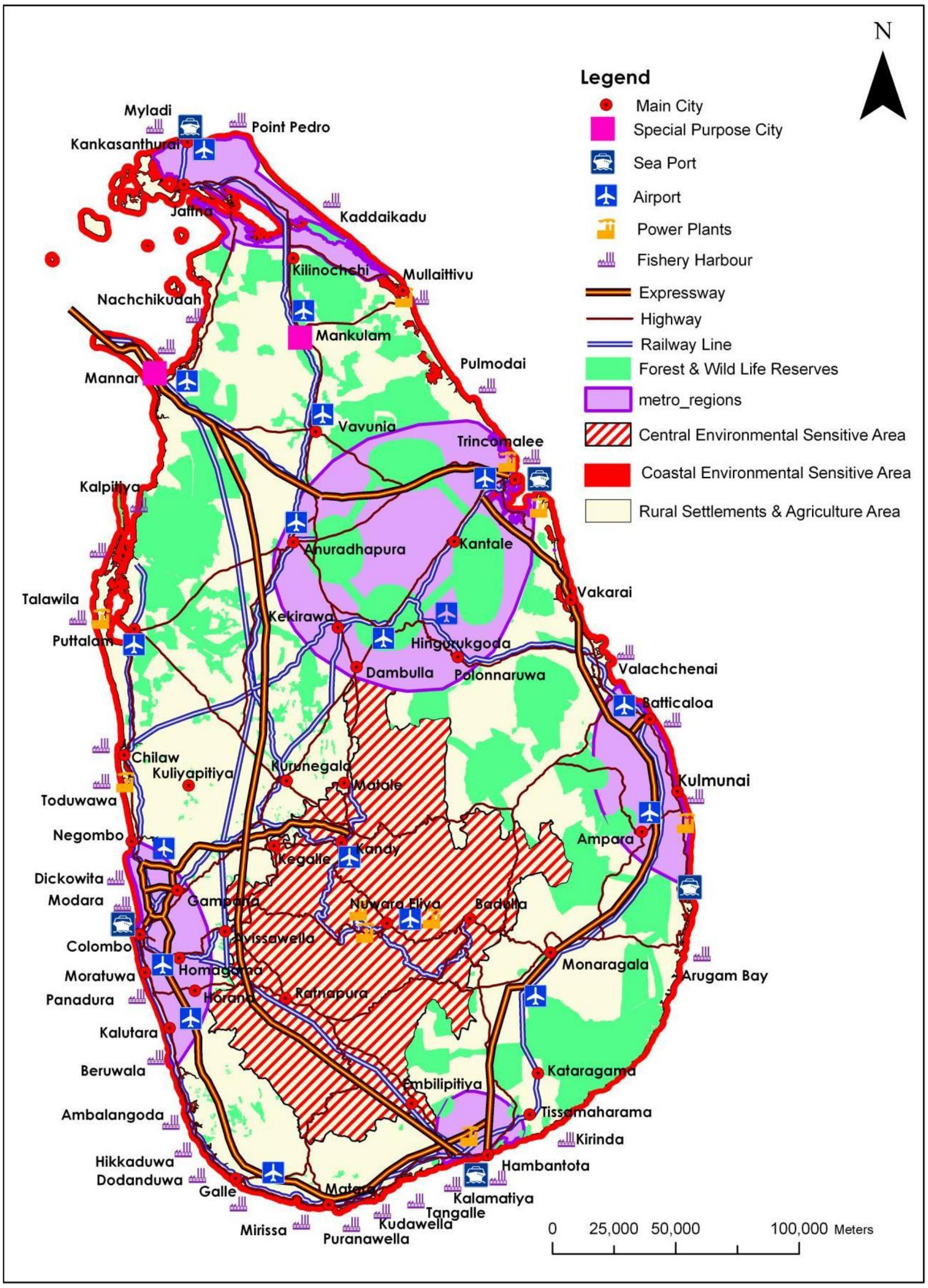
Development plan	Project	Priority ranking
Cities and Settlement	Regulate development in the Protected Area Network	1
	Protect and retain land with environmental values	2
	Create new cities and settlements and encourage an outward movement of population and plantations from the PAN and CFA	3
	Northern Province Regional Structural Plan	-
	North central metropolis	-
Infrastructure	Maintain and rehabilitate the existing road network and construct regional highways to urban regional centers	1
	Develop bus networks to improve inter-city and intra-city connections	2
	Upgrade and extend the railway network for passenger and freight travel	3

Development plan	Project	Priority ranking
	Develop regional and international ports and supporting infrastructure to reinforce sea based economic gateways to Sri Lanka	4
	Improve domestic and international aviation linkages for passenger transport and expand capacity for air based cargo transport	5
	Enhance telecommunications networks	6
	Ensure the sustainable management, treatment and disposal of solid waste and sewerage	7

❍ National Spatial Structure Plan

– The spatial structure in question will provide the means of achieving the key elements of the National Physical Planning Policy. The spatial pattern promoted by the National Physical Planning Policy will allow designation of important environmental protection areas and at the same time provide an infrastructure network that will be the focus of economic and social activity and provide support the settlement structure and economic activities. It will contribute to the integration of communities, land use, transport and economic activity and reduce regional social and economic disparities.

– The construction of international air and sea ports will promote Sri Lanka's role in the South Asian Region, while domestic transport infrastructure such as roads and railroads will help meet demand for movement of goods and people. The proposed major transport infrastructure will be located outside the fragile areas designated according to the importance of these sensitive areas such as environmental, social and economic assets. The designation and protection of fragile areas contributes to a strong environmental sustainability component to the National Physical Plan Policy and will enable all Sri Lankans to enjoy these areas even in the future.



[Figure Ⅱ-8] National Spatial Structure Plan

2.2.National ICT Status

2.2.1.e-Sri Lanka

❍ The government of Sri Lanka first acknowledged the need for ICT development through the National Computer Policy established in 1983 by a committee organized by the Ministry of Natural Resources, Energy and Science Authority (NARESA).

❍ The government of Sri Lanka established a nationwide ICT development agenda called 'e-Sri Lanka' in November 2002 to raise the efficiency of government administration and provide effective public services using ICT and defined the six key areas.

[Table II-11] Six Key Areas of e-Sri Lanka

Area	Direction
Re-engineering Government	• Provide effective public services by using ICT in government administration and create a citizen-centric government • Deliver public services effectively and appropriately to people's doors or provide them through the community information centers, free of charge
e-Society	• Meet the socioeconomic needs of ICT vulnerable classes • Set up an e-Village for socioeconomic development in marginalized areas and expand the use of ICT applications • Run e-Class rooms for the visually impaired
Information Infrastructure	• Expand opportunities for citizens to access ICT to promote the construction of ICT infrastructure and industry and provide communications services for the poor at low prices • Set up Nenasalas (Nena=Konwledge + sales = shops) and provide computer technology, Internet and IT skills training, etc. to the vulnerable class
ICT Human Resources and Capacity Building	• Utilize ICT at the national level to supplement insufficient ICT human resources • Develop and manage human resources through education • Develop ICT-related industries and create new jobs
ICT Investment & Private Sector Development	• Develop realistic policies that can be supported by the state in regard to an exporting sector where Sri Lanka's biggest economic activities are occurring with the aim of revitalizing the economy using ICT • Develop Sri Lanka's IT industry: software industry, IT outsourcing industry, IT infrastructure, IT education and IT consulting service • Recombine ICT products and services with investment
ICT Policy, Leadership & Institutional Development	• Improve the use of ICT and seek institutionalization to support ICT leadership and capacity building • Develop the ICT leadership of high-ranking officials major entities requiring restructuring

❍ The e-Sri Lanka policy includes matters concerning building national information infrastructure, creating a framework for promoting software and ICT industries, redesigning government processes, and developing human resources specialized in ICT.

[Table Ⅱ-12] e-Sri Lanka's Direction of Development

Category	Description
Industrial development	- Increased sales through improved competitiveness and job creation: USD 5 billion in income for the private sector and employment of 200,000 people by 2020 - Promotion of Sri Lanka as an ICT and BPO investment destination - Increased corporate productivity
Digital infrastructure development	- Provide high-speed wide area network (WAN) to government agencies: plans to connect 3,500 government agencies and buildings at a bandwidth of at least 100 Mbps - Increased access to government services by providing Wi-Fi facilities to government employees and citizens - Set up an industry-standard government cloud for hosting all government services, portals, public and shared services, and mobile applications - Implement a big data analysis and open data platform by implementing big data clusters
Modernization of government	- Implement new ICT-based administrative policies to redesign and improve government processes to ensure government efficiency and transparency as well as the efficiency of civil services
Capacity building	- Build digital government capacity - Build the capacity of all public sector employees to effectively perform citizen-centered public services and become competent persons - Provide high-quality lifelong learning opportunities to everyone through digital technologies irrespective of geographic or other boundaries. - Distribute digital education technology and content and facilitate adoption thereof - Facilitate ecosystem setup in the education sector for effective ICT intervention and adoption - Provide appropriate infrastructure and solutions for smooth delivery of local and international education - Provide appropriate infrastructure and solutions to facilitate the delivery of education
Development of legal and institutional framework	- Provide legal and institutional environment to promote electronic commerce: provide the legal environment necessary for using electronic data and documents and carrying out electronic transactions with the preparation of eLaws - Provide data protection policy and reinforce the Intellectual Property Law
Security	- ICTA helped draft major legislations on ICT; major policy reforms were pursued to promote the transition into electronic systems; and ICT development schemes were prepared (Sri Lanka Computer Emergency Readiness Team, SLCERT, etc.). - The Computer Crimes Act No. 24, 2007 provides procedures to identify computer crime and carry out criminal investigation and enforcement - The provisions of the Electronic Transactions Act No. 19, 2006 were set forth based on the standards established by the United Nations Commission on International Trade Law (UNCITRAL) Model Law on Electronic Commerce (1996) and the Model Law on Electronic Signatures (2001).
Citizen capacity building	- Develop the capacity necessary to lead and implement ICT programs - Rapidly develop digital infrastructure needed nationwide to effectively serve all citizens - Create an environment for the knowledge economy - Develop specialized and extensive ICT skills at all levels of education - Provide faster, more efficient and transparent government services to all citizens and private companies - Use ICT as a means to achieve social development - Create jobs through dynamic and competitive ICT sectors

2.2.2. Direction of ICT Development

❍ Sri Lanka Telecom (SLT) is the sole entity in Sri Lanka to be in possession of a cable network .In 1997, Japan's NTT made an investment equivalent to approx. 35% of the shares to obtain the rights to jointly operate the company.

❍ Companies that operate wireless telephone networks in addition to wired networks include Dialog Broadband Networks, Lanka Bell, and Sri Lanka Telecom.

❍ Sri Lanka has a well-developed mobile communications market. As part of its efforts to emerge the IT hub of Southwest Asia, Sri Lanka was the first in the region to introduce 4G technology .The penetration rate is very high in Sri Lanka, which has a population of 20 million, with 90%of the population using 2G wired networks and 70% using 3G wired networks.

❍ In 2015, the number of landline (fixed-line) phone subscribers decreased 4% year-on-year, while the number of mobile phone subscribers increased 10.2%. With the number of mobile telecommunications service subscribers on the rise, the number of fixed-line phone subscribers has been declining.

❍ Individuals have several USIM cards in order to obtain promotional benefits from multiple mobile carriers. This is why the telephone density (number of phones per 100 people) in Sri Lanka is quite high at 128.7.

[Table Ⅱ-13] Telecommunications Service Penetration Status in Sri Lanka

Category	2012	2013	2014	2015	2016
Wired communications subscribers	3,449,000	2,707,000	2,710,000	2,601,000	2,480,000
Wireless communications subscribers	20,324,000	20,315,000	22,123,000	23,900,000	25,797,000
Telephone density	117	112.4	119.6	128.7	128.8
Internet penetration	18.3%	21.9%	25.8%	30.0%	32.1%

* Source: 2016 Annual Report, Central Bank of Sri Lanka

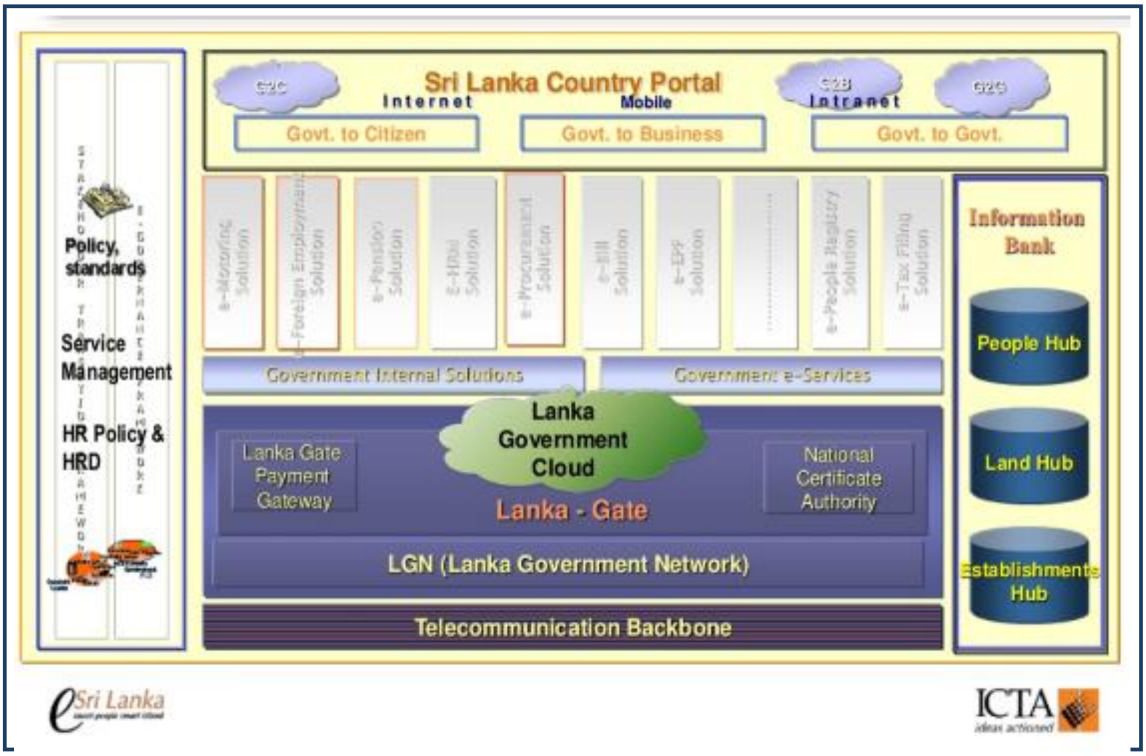
❍ There are five mobile carriers in Sri Lanka, and competition among the carriers is fierce. As of 2015, the biggest market share is held by Dialog (10 million, Malaysia), followed by Mobitel (7 million, Sri Lanka Telecom), Etisalat (4.5 million, UAE), Hutch (2 million, Hong Kong), and Airtel (1.7 million, India). There is reliance on the foreign companies that have expanded into Sri Lanka for Import and maintenance of parts and equipment for mobile telecommunications.

❍ Major foreign companies are Huawei, Ericsson, Alcatel and Zte. Huawei, in particular, entered the Sri Lankan market in 2012, and its sales in the first half of 2015 increased 300% year-on-year.

❍ Mobile carriers generally do not purchase parts and equipment from foreign companies that have not entered Sri Lanka, but as of 2015, Apple iPhones and Samsung Galaxy are gaining massive popularity in Sri Lanka.

❍ In July 2015, the government of Sri Lanka concluded an agreement with Google to implement the Google Loon Project with the aim of providing 4G services nationwide. It is estimated that, as of 2017, 4G is used by 4,232,675, which is around 20% of the total population of Sri Lanka.

❍ The e-Government architecture is based Lanka government which connects lanka Internal solutions and government E-services through LGN and telecommunication backbone which the e-Government services are provided to users in the single two-way portal mode



[Figure II-9] LGN (Lanka Government Network)

[Table Ⅱ-14] ICT Status of Sri Lankan e-Government

Category	Description	
ICT Infrastructure & Information to Citizen	LGN	Lanka Government Network: Linking more than 500 government organizations
	Lanka Gate	Electronic services platform and national portal (incl. payment gateway service)
	GIDC	Development and hosting of websites of more than 500 government organizations
	Lanka Government Cloud	Implementation of Lanka Government Cloud and provide IaaS, PaaS and AaaS

Category	Description	
	GIC	Government Information Centre-1919: Provide information on more than 3,000 public services of 300 government agencies
IT System	BMD	Digitalization of birth certificates, marriage certifications and death certificates
	Population Registry	Automated system for civil registration
	e-SLIMS	Sri Lanka Land Information Management System
	e-Pensions	Automated pension system
	e-Local Govt.	Automated application system
e-Service	Online Vehicle Revenue License (Road tax)	Vehicle information, vehicle number reservation, issued vehicle number, home loan details, test application processing, application for test re-issuance, test certificate issuance, etc.
	Payments	Transportation fares, intercity and express train tickets, arrival visas, etc.
	Inquiries	Crop prices, average price of tea plant, train schedule service, overseas job opportunities, etc.
	Status	Passport application, visa application, police clearance certificate, NIC application, birth and citizenship application

❍ Since 2016, ICTA, which oversees the ICT policy, has established and promoted ICT development strategies that include construction of information infrastructure, creation of related environment, ICT human resource development, modernization of the government, civil service provision, and ICT utilization and promotion for economic and social development.

❍ Building digital infrastructure is the key strategy to provide all citizens with the benefits of ICT. The development initiative includes several plans to make government services efficient, convenient and friendly in parallel with this strategy.

❍ The Lanka Government Network (LGN) linking more than 500 government agencies has already been set up, and the Lanka Government Cloud (LGC) provides cost-effective and reliable services.

❍ To achieve the goal of becoming a digitally inclusive nation, the limitations and constraints of LGN and LGC must be eliminated, and services must be able to expand rapidly in accordance with the latest technology trends.

❍ To this end, there are plans to connect 3,500 government agencies with a bandwidth of at least 100Mbps and connect the postal networks to be extended across up to 7,500 regions.

❍ In all of these regions, a Wi-Fi environment will be set up so that citizens can easily access government services, and the next version of LGC will provide industry-standard cloud services.

❍ Big data analysis, which can be used effectively for the nation's economic growth, and open data portals in line with national priority projects are two key outcomes of the big data cluster project.

❍ An Internet backbone that is significantly bigger than the current size of the government network has been proposed, but to ensure adequate Internet bandwidth, the government of Sri Lanka plans to establish a government data center and a national security operations center (SoC).

❍ All these digital infrastructure improvements are underway for sequential digital revolution (Source: e-Government Policies & Procedures, ICTA).

❍ Infrastructure is being built for five purposes (Source: e-Government Policies & Procedures, ICTA).:

- First, it is to provide high-speed wide area network (WAN) to government agencies;
- Second, it is to provide Wi-Fi facilities for government employees to use e-Government services conveniently;
- Third, it is to increase access to government and related services for citizens through Wi-Fi facilities;
- Fourth, it is to build a government cloud hosting all government services, portals, public/shared services, and mobile applications;
- Fifth, it is to implement a big data analysis and open data platform by implementing big data clusters (Source: e-Government Policies & Procedures, ICTA).

2.2.3. ICT Business Status

1) ICT Private Company List

[Table Ⅱ-15] ICT Private Company

Company Name	Address	Description	Homepage
Metropolitan	85, Braybrooke Place, Colombo, Sri Lanka	IBM/Acer Lap Top, Canon Printer and Copt Machine SI Project and Maintenance	www.metropolitan.lk
Enterprise Technology	No.65, Braybrooke Place, Colombo, Sri Lanka	Provide CISCO network-solution Network Maintenance and capability for SI Project	www.enterprisetl.com
KBSL Information Technologies Limited	297 Union Pl, Colombo, Sri Lanka	Provide/Develop/Consult for Business Solution SI(System Integrator)	www.kbslit.com

Company Name	Address	Description	Homepage
N-able	36 Bristol St, Colombo, Sri Lanaka	N-central(PC Management Solution) MSP(Managed Service Providers) Provide N-compass Construction for Dialog IDC	www.n-able.biz/
JITG (Just in Time Group)	370 A2, Colombo, Sri Lanka	Provide/Develop/Consult for Business Solution for Government, Bank and Insurance company SI(System Integrator)	www.jithpl.com

2) Wage information in Public and Private

[Table Ⅱ-16] Sri Lanka Wage Status for ICT (in Government)

LKR

	Less than 1 year Experience		1 to 4 years' Experience		4 to 8 years' Experience		Over 8 years' Experience	
	Min	Max	Min	Max	Min	Max	Min	Max
Digital media and animation	<20,000	40,000	<20,000	40,000	<20,000	40,000	<20,000	40,000
Systems and network administration	<20,000	60,000	<20,000	50,000	<20,000	50,000	<20,000	90,000
Programming/ software engineering	<20,000	60,000	<20,000	40,000	<20,000	50,000	<20,000	60,000
Software quality assurance	<20,000	60,000	<20,000	30,000	<20,000	40,000	<20,000	40,000
IT sales and marketing	<20,000	<20,000	<20,000	30,000	<20,000	30,000	<20,000	30,000
Technical support	<20,000	60,000	<20,000	40,000	<20,000	50,000	<20,000	60,000
Web development	<20,000	40,000	<20,000	40,000	<20,000	50,000	<20,000	60,000
IT research and development	<20,000	40,000	31,000	40,000	31,000	50,000	<20,000	60,000

Source : ICTA_ICT Workforce Survey Report ('13)

[Table Ⅱ-17] Sri Lanka Wage Status for ICT (in private companies)

LKR

	Less than 1 year Experience		1 to 4 years' Experience		4 to 8 years' Experience		Over 8 years' Experience	
	Min	Max	Min	Max	Min	Max	Min	Max
Digital media and animation	<20,000	60,000	<20,000	70,000	20,000	150,000	31,000	200,000
Systems and network administration	<20,000	70,000	20,000	90,000	31,000	150,000	41,000	200,000
Programming/ software engineering	<20,000	70,000	20,000	150,000	31,000	200,000+	51,000	200,000
Software quality assurance	<20,000	70,000	20,000	150,000	31,000	200,000	41,000	200,000
IT sales and marketing	<20,000	70,000	<20,000	90,000	20,000	150,000	20,000	200,000
Technical support	<20,000	70,000	<20,000	70,000	20,000	150,000	20,000	200,000
Web development	<20,000	70,000	20,000	80,000	20,000	150,000	31,000	200,000
IT research and development	<20,000	80,000	20,000	150,000	31,000	200,000+	41,000	200,000

Source : ICTA_ICT Workforce Survey Report (′13)

3) NDC(National Data Center) standard price for Co-Location

[Table Ⅱ-18] NDC(National Data Center) standard price for Co-Location

LKR

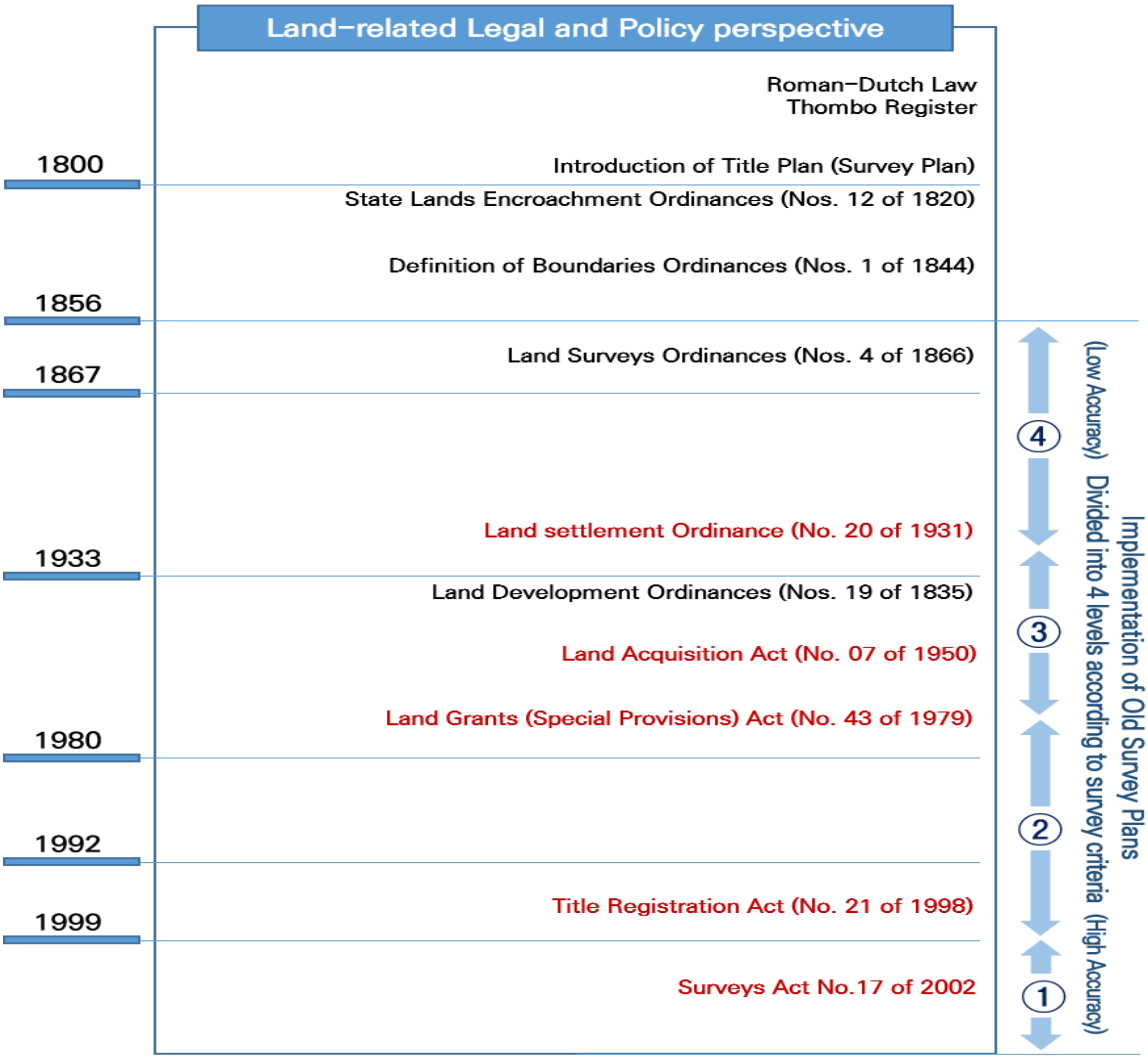
Category	Type-A	Type-B	Type-C	Type-D
Power feed options	16A x 2*	32A x 2*	16A x 2*	16A x 2*
Redundancy options	Basic	Basic	Advanced	Advanced
Monthly Rental Full Rack (42U)- Infrastructure Exclusive of Power	95,000.00	110,00.00	100,000.00	120,000.00
Monthly Rental Full Rack (42U)- Power Usage	75,000.00	160,000.00	80,000.00	170,000.00
Maximum Power Usage	3.6KVA	7.2KVA	3.6KVA	7.2KVA
Total Monthly Rental Full Rack (42U) Inclusive Power	170,000.00	270,000.00	180,000.00	290,000.00
Pricing for SLT Owned Rack Infrastructure(Monthly) Service Initiation Charge : Rs 20,000.00				

3. Land Information Policy and Management Status

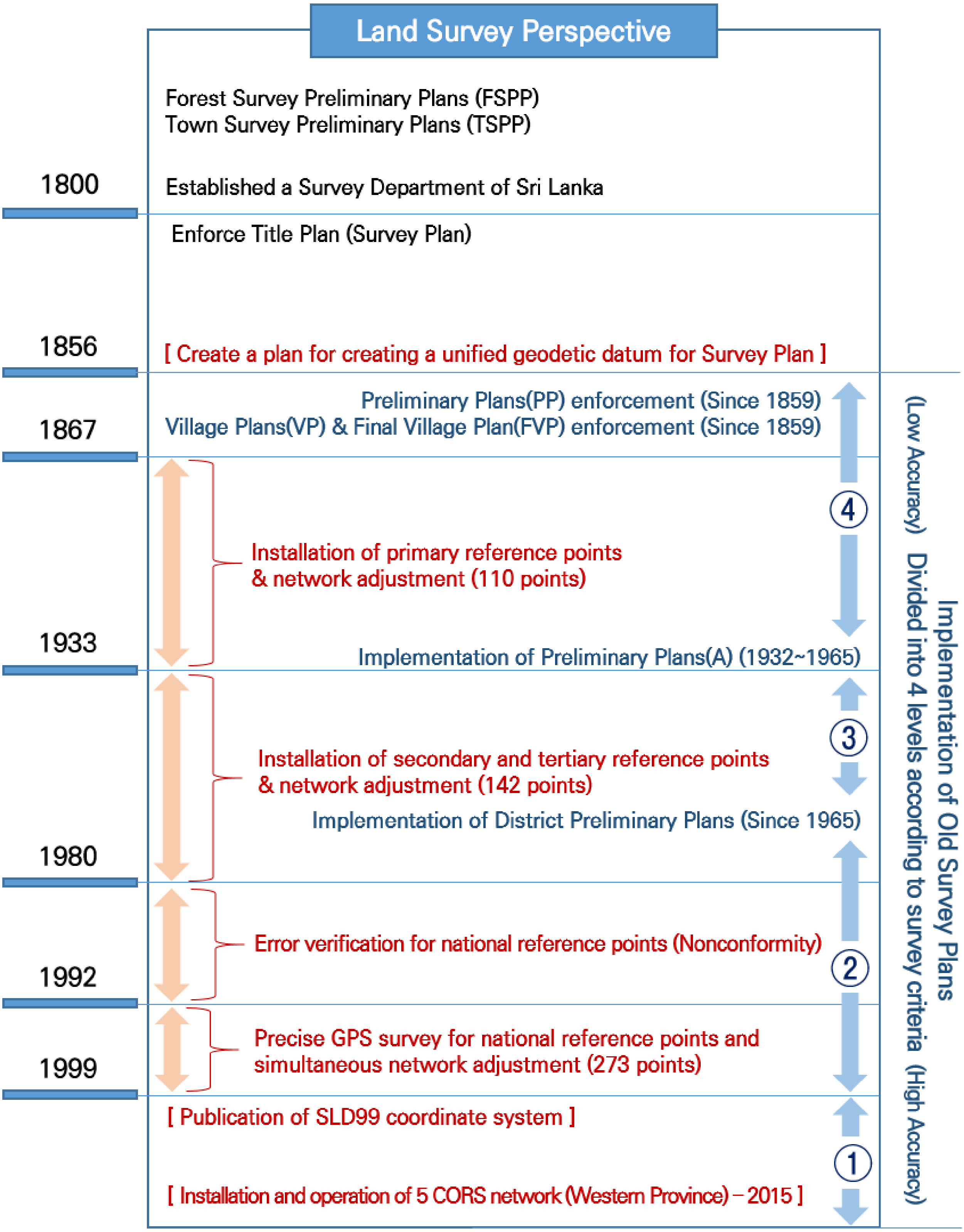
3.1. Overview

❍ In Sri Lanka, the concept of systematic land management was introduced with the establishment of the Survey Department (SDSL) in 1800 during a time when it was still under British colonial rule, and this formed the basis of land information regarding the entire territory of Sri Lanka.

❍ From 1800, laws and systems for land management were established, practical survey concepts were introduced, and the concept of survey plans for land boundaries began to be established, along with the establishment of the SDSL, it has been the foundation of Sri Lanka's policies related to land information and has the following historical trends:



[Figure II-10] Historical trends from land-related legal and policy perspective



[Figure II-11] Historical Trends from land survey perspective

3.2. Laws and Institutions Related to Land

❍ Sri Lanka's land-related laws and institutions were the most affected by its political history. All land was originally owned by the king.

❍ Starting in 500 BC, a le/gal document called "Sannasa" was be used to grant religious members or subordinate rulers of the king (minority ruling class) the rights to the use of land, and these records are found in a land register called "Lakam-Mitiyas".

❍ In 1505, there was a switch in the land register from "Lakam-Mitiyas" to "Thombo Register", and the latter continued to be used during the 150-year Portuguese rule.

❍ The Roman-Dutch Law was introduced under the 140-year Dutch rule after 1656 and this became the impetus for the establishment of a common law on land in Sri Lanka.

❍ In accordance with the Roman-Dutch Law, a transition from the land register, "Thombo Register", continued. Parts of the "Thombo Register" are kept by the Sri Lankan Department of National Archives and in Kandyan, related records have been issued at the request of ordinary citizens as reference materials for assessing the legal rights to land.

❍ Sri Lanka was then ruled by Britain for about 150 years starting in 1796. Until 1948 when it finally gained independence, it was called "Ceylon" and this marked the time during which there was growing awareness of the importance of land management leading to an era of land ownership.

❍ In 1800, the United Kingdom introduced the title plans system for the purpose of exploiting Sri Lanka's land and labor. The Survey Department of Sri Lanka (SDSL) was also established to maintain the system of land rights through surveying and production of survey plans began.

❍ The establishment of the private land ownership system resulted in a widespread wealth inequality, and most households in urban areas live on small pieces of land or in unauthorized residences on government lands.

❍ Land title certificates based on the title plans with commercial value have become very important grounds for land transactions, and various land regulations and administrative ordinances have been promulgated to maintain them.

❍ The land-related statutes that have been maintained to this day first started being established in 1820 for the purpose of preventing infringement on state-owned lands. The following statutes have been established and amended in reflection of the changes in social conditions:

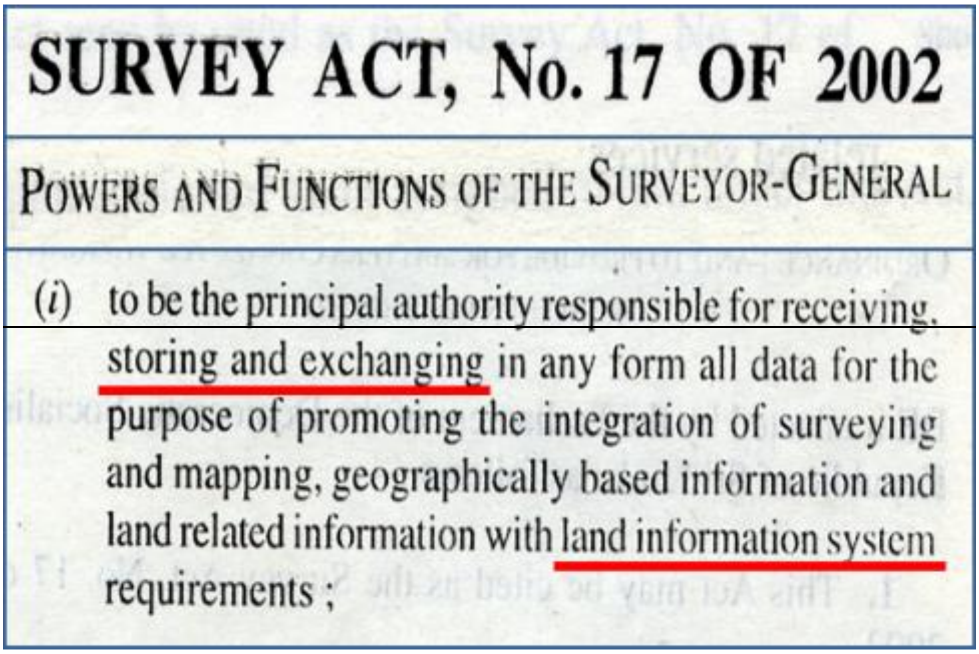
– State Lands Encroachment Ordinance (Nos. 12 of 1820, 22 of 1931, 8 of 1947, Act No. 8 of 1954): An ordinance establishing provisions on preventing infringement on state-owned lands

- Definition of Boundaries Ordinances (Nos. 1 of 1844, 13 of 1905, 28 of 1919, 27 of 1933, 8 of 1947 ordinances and Act No. 22 of 1955): An ordinance establishing provisions for effective assessment of land boundaries
- Land Surveys Ordinance (Nos. 4 of 1866, 2 of 1917): An ordinance introduced to reinforce the requirement for surveying for land title certificates and the reliability of land surveys and their results and later replaced by the Survey Act No. 17 of 20022
- Land Settlement Ordinance (No. 29 of 1931): An ordinance introduced to resolve land disputes (forming the basis for land title registration)
- Land Development Ordinance (Nos. 19 of 1935, 3 of 1946 Acts Nos. 49 of 1953, 22 of 1955, 16 of 1969, and 21 of 1971, Law No. 43 of 1973): An ordinance for efficient land development and assignment of state-owned land (requires provision of information on land)
- State Land Ordinance (No. 8 of 1947): An ordinance for leasing and granting state-owned lands that was introduced for land and coastal management, regulation of use of water resources, and resolution of related issues (specifies matters concerning the use of state-owned lands)
- Land Acquisition Act (No. 9 of 1950): An ordinance for acquiring land for public purposes and for coordinating various issues resulting from the acquisition (specifies matters concerning land use for public purposes).
- Land Grants (Special Provisions) Act (No. 43 of 1979): An act for supplying farmlands and real estate lands under the land reform law (specifies matters concerning land use)
- State Land (Recovery of Possession) Act (No. 7 of 1979): An act for resolving land ownership issues with respect to disputes arising from unauthorized occupation of state-owned land (specifies matters concerning land use)
- Title Registration Act (No. 21 1998): An act regarding investigation and registration of land centering on land units (specifies the regulations on land transactions and matters concerning land use).

❍ As for the land system in Sri Lanka, the land certificate system accompanied by surveying began to be implemented in full swing with the introduction of the Land Surveys Ordinance in 1866.This became the impetus for active production of survey plans (Survey Plans: Village Survey, Topo Preliminary Survey, Preliminary Survey).

❍ With the enactment of the Title Registration Act in 1998, investigation and registration of land became mandatory for land transactions, and this led to the transition from old system of “deed” to the system of “titles” as proof of land ownership. Base on this, a Land Titling Related service projects began. In 2007, a new Title certificate for land issuance system was introduced, which is the Bim Saviya Program.

❍ Land Surveys Ordinance was replaced by the Survey Act No. 17 in 2002. It became the basic status for land surveying, mapping, geo information production & management and land management in Sri Lanka



SURVEY ACT, No. 17 OF 2002

POWERS AND FUNCTIONS OF THE SURVEYOR-GENERAL

(*i*) to be the principal authority responsible for receiving, storing and exchanging in any form all data for the purpose of promoting the integration of surveying and mapping, geographically based information and land related information with land information system requirements ;

[Figure II-12] Survey Act, No. 17 of 2002

❍ The current land system in Sri Lanka is largely divided into state-owned and private lands, and the rights to land are divided as follows:

– Private lands with freehold titles which the owner has to right to transfer or dispose of lands

– Provincial lands that the government and local councils can divide and regulate

– Land that the state has absolute ownership right to under the Land Development Ordinance (LDO)

– Land owned by state-owned enterprises or related ministries

– Jayaboomi which are lands given to the people as state grants under certain conditions

❍ Agricultural lands, which can be jointly owned like a collective farmland, are divided into three types:

– Thattumaru: the co-owners of a piece of land take turns in cultivating it.

– Kattimaru: the land is subdivided into parcels which are cultivated in rotation by co-owners who only own the crops growing in their respective plots

– Ande: the land owner gets another person to help cultivate crops on the land and pays him with a share of the crop

❍ The taxes imposed on private land in Sri Lanka are divided into state tax and local tax, and property tax is included in local tax.

– The property tax in Sri Lanka is not conceptualized as a holding tax imposed on the land in one's possession, as is the case in Korea, but it is instead calculated in relation to the lease value of the land.

– Property taxes are imposed to fund public services in the area under jurisdiction of the authorities that oversee the land in question.

– In Sri Lanka, the average price of residential parcels (16.5 square fee) in 2018 rose 15.3% from 2017 to LKR 1.36 million (approx. USD 7,780), and the price of land in Colombo also increased 5.5% to LKR 1.56 million (approx. USD 66,130) in the same period.

– In the case of Colombo, property taxes are expected to rise due to foreigner investment in real estate.

– Those required to pay property taxes are not clearly defined, but all owners of real estate properties are generally required to pay the tax. In case of failing to pay the property tax for more than two quarters, the government seizes the property under state treasury.

3.3. Survey Plans

❍ Systematic land survey and subsequent land records introduced by the United Kingdom in land administration have become the most important mechanism for land ownership and land transactions. The British established the Survey Department of Sri Lanka (SDSL) in 1800 and began implementing the title plans system according to survey plans.

❍ SDSL, established in 1800, began producing various types of survey plans necessary for land management and established the title plans system. The hard copies of the title plans are stored in the SDSL archive.

❍ The types of survey plans currently retained by SDSL are as follows:

[Table Ⅱ-15] Types of Survey Plans

Category of Title Plan	Purpose	Period Issued
- Title Plan - Title Plan(T)	- Property Transaction & - Commercial purpose	- 1800 to 1934 - 1934 to 1942
- Acquisition Title Plans - Mining Right Title Plans - Crown Title Plans	- For land Acquisition - Mining right purpose - For Crown lands	- 1892 to 1912 - 1915 to 1940 - 1937 to 1938
- Preliminary Plans - Preliminary Plans(A) - District Preliminary Plans	- For issue of grants on - settlement purpose - Land acquisition, Vesting & - alienation purpose	- 1859 to 1932 - 1932 to 1965 - 1965 till now
- Village Plans(VP) - Final Village Plans(FVP)	- Less populated village areas, settlement purpose	- 1859 to 1958
- Topographical Preliminary - Plans (ToppPP)	- Very low populated & remote areas, Settlement purpose	- 1917 to 1954
- Irrigation Survey - Preliminary Plans (ISPP)	- Irrigation Scheme areas - For Settlement purpose	- 1916 to 1986
- Forest Survey preliminary - Plans (FSPP) - Town Survey preliminary - Plans (TSPP)	- Settlements in forestry areas - Settlement on town vicinity	- Prior to 1980

❍ SDSL introduced systematic survey plans for the whole country in accordance with a long-term survey program for the first 50 years and conducted village surveys, topo preliminary surveys and preliminary surveys.

❍ For this purpose, a wide variety of survey techniques were introduced, and the method of preparing survey plans was decided in consideration of the density of residents living in each region.

1) Preliminary Plans (PP)

– Preliminary plans (PP) are survey plans for land administration purposes that are legally effective. They were implemented sporadically at the request to transfer state-owend lands to private ownership. Serial numbers starting from 1 were assigned in the order in which surveying was performed between 1859 and 1932, while serial numbers starting with A (e.g. A1) were assigned between 1932 and 1965.

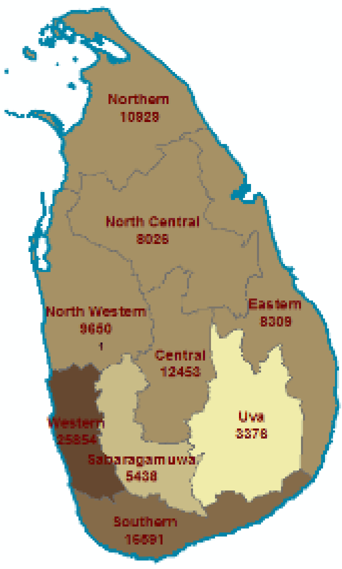
– From 1965 to the present, serial numbers combined with the district code have been assigned (e.g., in the case of the Colombo District, Co-1234).Prior to 1965, an average of 100,000 preliminary plans were carried out, and the largest number of preliminary plans were issued in the Western Province, which has the highest population density.

– Preliminary plans have been implemented since 1859 based on sporadic surveys. Surveying was not performed using a standardized control point coordinate system, but by setting up random control points within a local area. This is why a standardized coordinate system has not been maintained.

– Accordingly, in recognition of the need for a standardized coordinate system for the entire nation, control points have been set up by categorizing the coordinate system by region, based on which surveying has been carrying out starting in 1965. The distribution of preliminary plans produced at the request of local governments is as follows:

[Table Ⅱ-16] Preliminary Plans by Province

Provinces	PPA	PP	Total
WP	5,424	20,430	25,854
NWP	1,880	7,770	9,650
NP	2,499	8,430	10,929
CP	3,193	9,260	12,453
NCP	156	7,870	8,026
EP	1,469	6,840	8,309
SP	2,121	14,470	16,591
SAB.P	1,248	4,190	5,438
UVA.P	386	2,990	3,376
Total	18,376	82,250	100,626



2) Village Survey Plans

– A “village” is the smallest administrative unit in Sri Lanka and is considered as one survey block. The Village Survey, the first legally binding land survey in accordance with the Land Settlement Ordinance, began in 1931.

– In the Village Survey, also called the Block Survey or Lanka Survey, the scale of the drawing is formed by expressing a chain[16] from 1 to 4 in an inch, and the cadastral terrier information (land information) is managed as a list in the form of a table.

– Once the Village Survey is completed, the officer in charge of land adjustment (settlement) takes follow-up measures for the Village Plan through the Village-level Survey Plans. The Village Plan after the land adjustment (settlement) activity was then announced as a Final Village Plan.

– VP/FVP were survey plans conducted between 1859 and 1958 in order to manage the residences of residents at the village level.

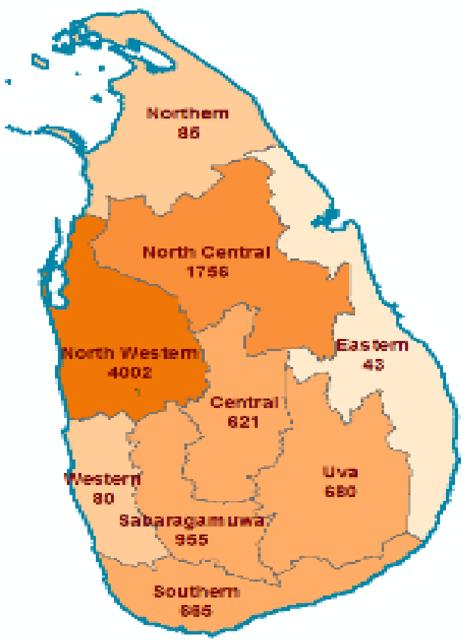
– VP/FVP were created based on sporadic surveying. Because surveying was not performed based on a standardized control point coordinate system and instead was carried out based on arbitrary control points set up in localized areas, a standardized coordinate system has not been maintained.

– The data were used as a basis for producing a national base map of Sri Lanka, and it was named 1-inch Map.

– The current surveying and survey activities related to land administration are based on VP (Village Plans) and Final Village Plans (FVP). A total of 8,887 VPs/FVPs have been published and the current status of VPs/FVPs of each province is as follows:

[Table II-17] VPs/FVPs by Province

Provinces	Total
Western Province	80
North Western Province	4,002
Northern Province	85
Central Province	621
North Central Province	1,756
Eastern Province	43
Southern Province	665
Sabaragamuwa Province	955
Uva Province	680
Total	8,887



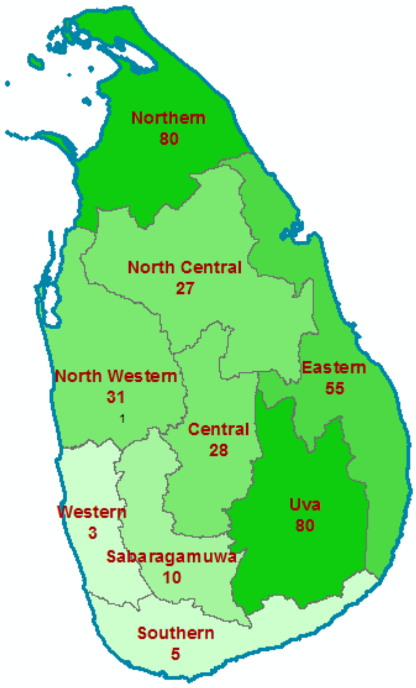
16 First developed by British mathematician Edmund Gunter (1581−1626) in the early 17th century. 1 Gunter's chain is about 20m and 1/100 of 1 Gunter's chain is called 1 link. One link consists of one iron rod, and the chain is used as the basic surveying unit for public land surveys in Canada and the United States. 10 square chain is 1 acre (ac).

3) Topographical Survey Preliminary Plans (TopoPP)

- Topographical survey preliminary plans (TopoPP) for regions with a small population are land survey plans created by sporadic (independent) surveying, rather than a continuous land.
- TopoPPs/FTPs are survey plans conducted between 1917 and 1954 to manage settlements in remote areas.
- TopoPPs/FTPs were created based on sporadic surveying. Because surveying was not performed based on a standardized control point coordinate system and instead was carried out based on arbitrary control points set up in localized areas, a standardized coordinate system has not been maintained.
- TopoPP# (e.g. TopoPP2) is assigned for a wide area and the smaller areas within the wide area are re-numbered by adding a dash (-) (e.g. TopoPP2-3). When a survey plan is produced for the village plan, follow-up measures are taken by the officer in charge of land adjustment (settlement) and the final topo plan (FTP) gets announced.
- TopoPPs/FTPs have been conducted for most of the rural areas and areas with forests. A total of 319 TopoPPs/FTPs have been published and the status of TopoPPs/FTPs for each province is as follows:

[Table Ⅱ-18] Status of TopoPP/FTP by Province

Provinces	Total
Western Province	3
North Western Province	31
Northern Province	80
Central Province	28
North Central Province	27
Eastern Province	55
Southern Province	5
Sabaragamuwa Province	10
Uva Province	80
Total	**319**



3.4. Bim Saviya Program

❍ Background

- Sri Lanka has previously used deeds as proof of land ownership through title plans according to survey plans; however, there have been attempts to switch to a new title certificate system starting in 2001.
- In 2007, the Bim Saviya Program was introduced to confirm land surveying results, manage ownership-related information in digital files, and provide the information via a website, and this has formed the basis of the current Land Information System (LIS).
- The land ownership certificate of the Bim Saviya Program serves as basic data for checking the exact land area and owner information at the time of land transaction. It also serves as a medium to support secondary economic activities such as bank loans based on land value and is used as a tool for strengthening competitiveness on the international stage when it comes to attracting foreign capital based on the economic value of land.
- Under the Bim Saviya Program, there is a distinction between land ownership registration for state-owned lands and land ownership registration for private lands. In the case of private land, the landowner’s consent is necessary, and thus various promotional campaigns have been carried out nationwide to induce voluntary participation of landowners.
- For state-owned lands, land surveying results are confirmed at the request of the entity in possession of the state-owned land in question and the ownership information of the entity is inputted for management. The necessary foundation has been laid in order to implement a wide range of policies for the transfer of state-owned lands to the private sector such as lease and transfer.

[Figure II-13] PR Materials for the Bim Saviya Program

❍ Bim Saviya Procedure[17]

- The Bim Saviya Program consists of a 6-step procedure for all the entities concerned in land registration can perform their respective tasks properly, and such entities include the Ministry of Lands and Parliamentary Reforms (MoLPR), Survey Department (SDSL), Land Settlement Department, Register General's Department, and Land Commissioner General's Department.
- The 6-step procedure is as follows: 1) AA: planning and monitoring, 2) BA: land information collection, 3) CA: land owner information acquisition, 4) DA: title certificate issuance, 5) EA: updates on land-related changes 6) FA: sharing of land information. The land survey results are confirmed through two of the steps: 2) land information collection and 3) land owner information acquisitio.
- The BA (land information collection) process refers to the process of confirming the parcel boundary and updating the details by collecting survey plans for the specified area and performing surveys on the registered land (parcel).

① BA1 (DS Division prepares survey plans and reference materials for implementation thereof)

- Update all the DS Division information available on System@LH
- Identify the black and update the system
- Select the location to establish a control point and update the information on System@LH
- Establish and check control points
- Collect basic information for traverse surveying related to the block

② BA2 (perform detailed survey for each parcel)

- Designate the surveyor for each block
- Perform traverse survey on the block boundaries and update System@LH with the information
- Perform traverse survey inside the block
- Define the requests for each related block
- Convey the requests for each related block to the surveyor
- Establish a detail survey plan
- Notify the landowner (occupant) of the time plan for field survey
- Perform field investigation and detailed field survey
- Register parcel information (coordinate information) on System@LH
- Capture field survey notes and register them on System@LH

③ BA3 (update matters related to land use by other entities)

- Register related entities wishing to use land (parcel) information
- Designate the persons-in-charge at registered entities
- Have the land use information updated by the related entities
- Have the registered information edited, updated, deleted, etc. by the related entities

④ BA4 (resolve boundary discrepancies for the adjacent parcels)

- Resolve boundary discrepancies within the same parcel for which survey is being performed

17 Referenced to Business Process Reengineering (BPR) Report of Title Registration Process and eLand Hub (eLH) System

- Resolve boundary discrepancies with adjacent parcels for which survey is being performed
- Establish a schedule and check the site to resolve boundary discrepancies

– CA (land owner information acquisition) refers to the process of acquiring and entering information on land history and landowner that may be used at the time of land registration

⑤ CA1 (landowner information acquisition for private land)

- Request or publish information about land within the specified DS Division
- Perform searches based on collected information
- Receive cadastral map from SDSL
- Link the acquired detailed information with cadastral information and publish it in the gazette
- Set the appeal period and process any appeals that have been received
- Determine ownership
- Declare ownership and publish it in the gazette
- Deliver the final land (parcel) information to the registration department

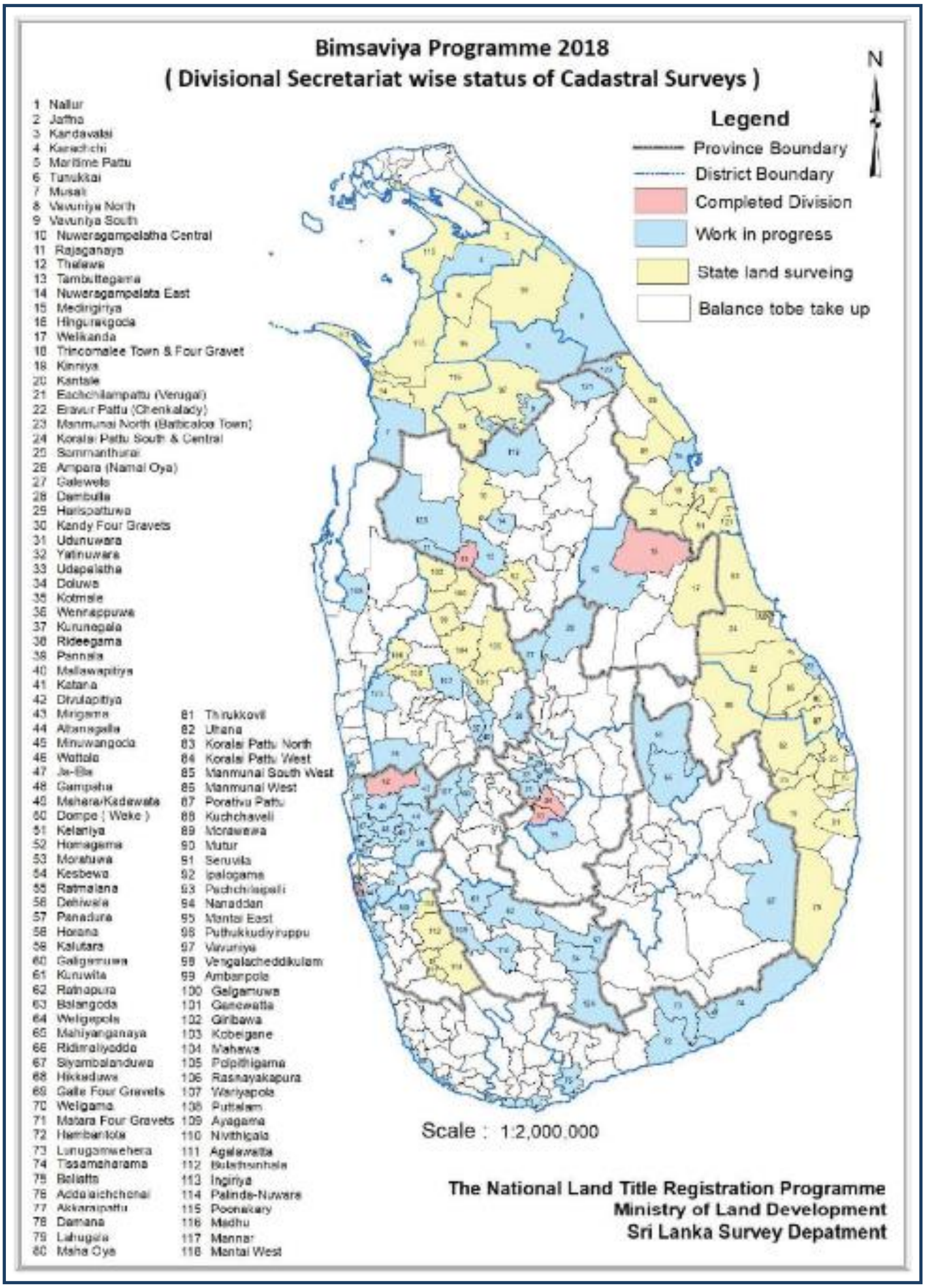
⑥ CA2 (landowner information acquisition for state-owned land)

- Acquire information on state-owned lands from the specified DS Division
- Declare land ownership
- Decide on documents related to land ownership
- Issue documents confirming land ownership

❍ Status of Bim Saviya Programme

– The land survey results for title registration were confirmed through the Bim Saviya Program, which was initiated in full swing in 2007. Title certificates have been issued for approx. 1,200,000 parcels, as of late 208, and this accounts for 4.9% of the national land of Sri Lanka.

– About 150,000 parcels of land are registered in the new title certificate issuance system each year through the Bim Saviya Program. This is quite low due to a lack of voluntary participation of landowners and the fact that the land title registration procedure (Bim Saviya Program) based on confirmation of land surveying results is not available online and thus is time-consuming. The progress of Bim Saviya Program as of the end of 2018 is as follow:



[Figure Ⅱ-14] Progress of the Bim Saviya Program (as of late 2018)

3.5. Management Status of National Control Points

❍ History and Background

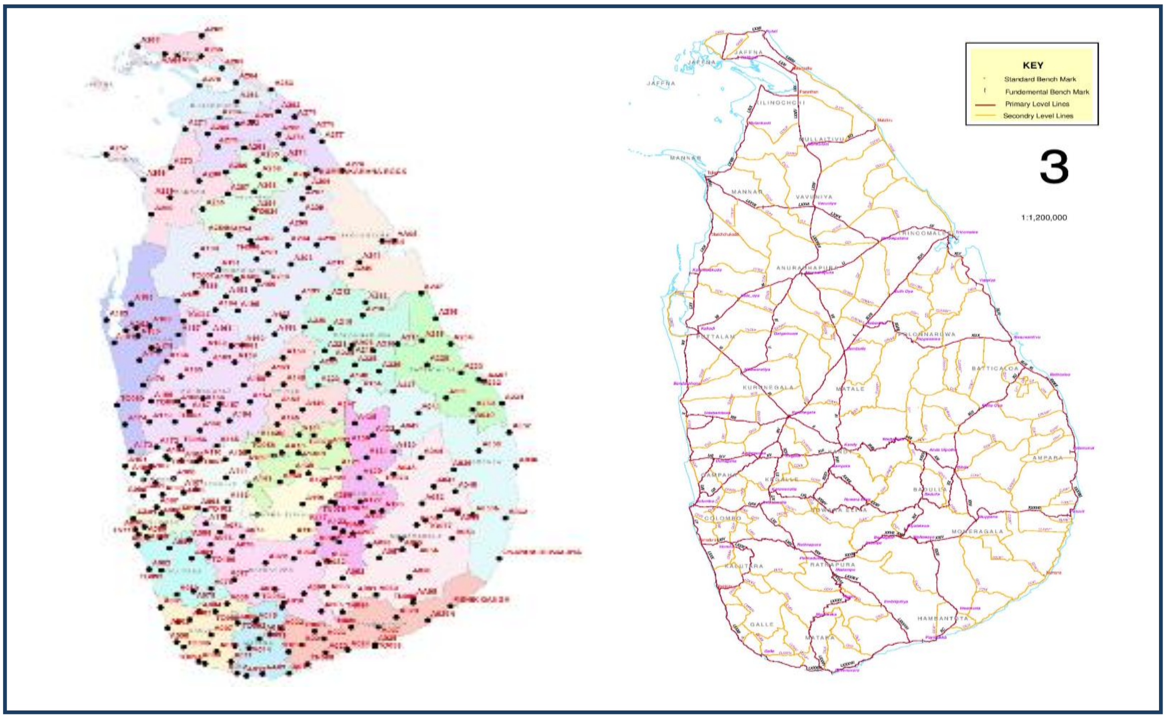
- Sri Lanka introduced a unified geodetic datum in 1856 to produce survey plans for the entire national land.
- In order to introduce a unified geodetic datum, a triangulation network has been established since 1867, with triangulation points set up where there is good visibility, and triangulation between the triangulation points was performed.
- The first triangulation was carried out by setting up 110 primary triangulation points along a distance of about 250km east-west from Colombo to Vavunativu.
- Adjustment calculations for the triangulation of the triangulation points set up initially were performed by J.E. Jackson in 1933 and the adjustment calculations for the 110 primary triangulation points led to an accuracy of about 1:20,000.
- The coordinates of the 110 primary triangulation points following the adjustment calculations were posted in 1933.
- In 1934, secondary and tertiary triangulation points began to be set up based on the primary triangulation points for triangulation.
- Verification of errors in national control points began to be performed in 1980.
- The inadequate surveying technology in the early day led to errors at each station to exceed the allowable level. Upon this discovery, non-conformance began to be checked for tasks accompanied by national surveying such as cadastral surveying, construction surveying, engineering surveying, LIS and GIS.
- In 1992, a national seminar was held to solve the aforementioned problem, and it decided to update the national reference network by introducing GPS survey enabling simultaneous network adjustment to an uniform degree across Sri Lanka.
- Precision GPS survey for national control points was initiated in 1992. In 1999, precision GPS survey for 273 national control points were completed.
- Precision GPS survey was performed using the static survey method,[18] and the network forming the basis of the national reference network was comprised of 10 stations based on the geodetic datum, with three 8-hour sessions of GPS survey conducted in relation to those stations.
- A static survey involving transmitting GPS observation data for more than 3 hours was carried out even for the 194 geodetic networks centering on the basic network comprised of a geodetic origin point and 10 stations.
- A national GPS reference network consisting of 273 stations was completed by conducting static GPS survey on 48 plane control points and 20 elevation control points centering on the national reference network including the geodetic datum.

18 Static survey: A precision GPS surveying technique for making observations with GPS receivers fixed in place for long periods of time. GPS surveying is largely divided into static observation and dynamic observation, and static surveying is the most common method of control point surveying applied to obtain highly accurate coordinates.

[Table Ⅱ-19] Components of the National GPS Reference Network

Category	Station	Number of locations	Note
1	Base Station (ISMD)	1	Geodetic Origin Point
2	Principal (AA) GPS Stations	10	Basic Network
3	Primary (A) GPS Stations	194	Reference network
4	Trigonometrical (TN, TO) Stations	48	Plane control points
5	Fundamental Bench Marks (FBM)	20	Elevation control points
Total (National GPS Networks)		273	

– In 1999, a simultaneous network adjustment was performed for 273 national GPS reference networks. The latitude and longitude results (λe, φe) on the Everest-1830 ellipsoid and the latitude and longitude results (λw, φw) on the WGS84 ellipsoid were determined for each station and were announced.



[Figure Ⅱ-15] Primary(A) GPS Stations & National Level Network

❍ SLD99 Coordinate System

- Sri Lanka uses a plane coordinate system that projects the Everest-1830 ellipsoid onto a cylinder. This plane coordinate system is used for mapping, cadastral survey, and general survey throughout Sri Lanka.
- Based on the results of national network adjustment in 1999, the standard for the projection of plane coordinates was published, and it was named as the SLD99 Coordinate System.
- The Everest-1830 ellipsoid was adopted as the reference ellipsoid of the SLD99 coordinate system.
- The Everest-1830 ellipsoid is comprised of a long axis (a) = 6377276.3450m and a short axis (b) = 63506075.4131m.
- The projection method for converting the longitude and latitude coordinates of the Everest-1830 ellipsoid into plane coordinates uses the Transverse Mercator (TM) projection method and one projection origin is used for the national land of Sri Lanka.
- The projection origin, scale factor, and virtual coordinates of the origin for the Transverse Mercator (TM) projection are as follows:

①	Longitude of the Origin	:	80°46′18.16710″E
②	Latitude of the Origin	:	07°00′0.169750″N
③	Scale factor	:	0.9999238418
④	False Northing	:	500,000m
⑤	False Easting	:	500,000m

❍ Datum Transformation Parameter for GPS Use

- Sri Lanka has recognized the need for a datum transformation parameter to convert the universalized GPS survey results into the SLD99 coordinate system.
- In the case of universalized GPS survey results, earth-centered, earth-fixed (ECEF) vertical coordinate system is presented as longitude, latitude and ellipsoidal height on the WGS84 ellipsoid. Thus, SLD99 coordinate system results can only be acquired if the GPS survey results are transformed into longitude and latitude results on the Everest-1830 ellipsoid.
- Accordingly, the datum transformation parameter has been calculated using the latitude and longitude results on the Everest-1830 ellipsoid (λe, φe) and the latitude and longitude results on the WGS84 ellipsoid (λw, φw) in relation to the national GPS reference network published in 1999.
- In order to convert the WGS84 ellipsoid results into the Everest-1830 ellipsoid results, Bursa Wolf's 7-parameter conversion method has been adopted.
- Transformation parameter for Bursa Wolf 7-parameter transformation are as follows:

①	ΔX	:	0.2933m
②	ΔY	:	-766.9499m
③	ΔZ	:	-87.7131m
④	Φ	:	0.1957040m
⑤	P	:	1.6950677m
⑥	K	:	3.4730161m
⑦	Scale Factor	:	1.0000000393

- 3-parameter for a simple transformation is as follows:

⑧	ΔX	:	97.000m
⑨	ΔY	:	-787.000m
⑩	ΔZ	:	-86.000m

❍ National Control Points Management System

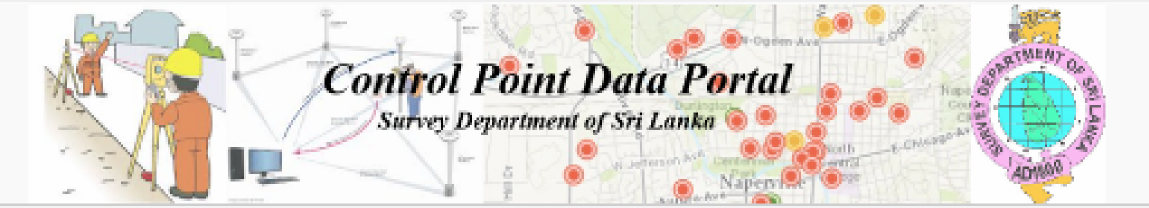
– Sri Lanka announced the GNSS Control Point Classification System to promote the universalization of GPS survey after the national GPS reference network adjustment in 1999 and manages the geodetic control points through the GNSS Control Point Classification System.

[Table II-20] GNSS Control Point Classification System

Category	Establishment of GPS Control Station	Principal (AA)	Primary (A)	Secondary (B)	Tertiary (C)
1	Accuracy	1:700,000	1:200,000	1:100,000	1:50,000
2	Mode of Observation	Static	Static	Static	Static
3	GPS Observation Session	3 Sessions of 8 Hours	3 Hours	3 Hours	45 Minutes
4	GDOP	〈 4	〈 4	〈 4	〈 6
5	GPS Receiver	Dual Frequency	Dual Frequency	Dual Frequency	Dual Frequency
6	Adjustment	Network	Network	Network	Network
7	Loop Closure	1:1,000,000	1:200,000	1:100,000 or 〈 3cm	1:50,000 or 〈 5cm
8	No. of Base Stations	3	3	3	2
9	Station Spacing	50~100 ㎞	15~35 ㎞	4~8 ㎞	0.1~0.5 ㎞

– SDSL manages a total of 23,307 geodetic control points according to the GNSS Control Point Classification System.

– These geodetic control points are managed in a database, which includes the control point numbers and names, coordinate results and location maps. The results have been made available to the general public via the website.



Home | View Data | Login | Help

Choose all data or data of the preferred district: All data   Horizontal Quality : All   Height Quality : All

View data

Client Point ID	SD Point ID	Requisition No	Grid Coordinates			Horizontal quality	Height quality
			Northing(m)	Easting(m)	MSL Height(m)		
BM-30	51TL-023-030	2015-199	497306	427818	19	TGPS	TL
11C1949	11C50441	2016/209	647913	459055	-100	TGPS	nodef
PL-73	91SL-404-072	2015-204	794161	421413	1	TGPS	SL
2A	42C51843	2017/037	559508	409732	-100	TGPS	nodef
11C2309	11C50675	2017/039	656737	488589	-100	TGPS	nodef
LVH-17	51SL-411-050	2015/210	504872	399367	3	TGPS	SL
32C2795	32C70601	2017/49	545739	517386	-100	TGPS	nodef
32C70802	32C70802	2017-112	533407	494641	-100	TGPS	nodef
CM54-SM22	72C20280	2016/281	485357	562345	-100	TGPS	nodef
STN001	41PL-312-015	2016/146	546669	405934	18	TGPS	PL
PLL003	42PL-312-002	2016/146	551359	410197	39	TGPS	PL
PLL006	42PL-312-006	2016/146	550041	409036	22	TGPS	PL
PLL007	42PL-312-007	2016/146	549716	408537	14	TGPS	PL
PLL008	42PL-312-008	2016/146	549267	408262	18	TGPS	PL
PLL011	42PL-312-011	2016/146	548203	406884	20	TGPS	PL
PLL012	42PL-312-012	2016/146	547782	406610	30	TGPS	PL
PLL014	42PL-312-014	2016/146	546903	405967	17	TGPS	PL
PLL013	42PL-312-013	2016/146	547359	406418	20	TGPS	PL
STN026	41PL-312-037	2016/146	543267	398035	8	TGPS	PL
STN027	41PL-312-038	2016/146	542628	395986	7	TGPS	PL
STN030	41PL-312-040	2016/146	541177	396000	8	TGPS	PL
STN031	41PL-312-041	2016/146	540840	396039	7	TGPS	PL
STN033	41PL-312-042	2016/146	539003	396303	7	TGPS	PL
STN034	41PL-312-043	2016/146	539553	396454	7	TGPS	PL
STN035	41PL-312-044	2016/146	538860	396547	6	TGPS	PL
STN036	41PL-312-045	2016/146	538398	396841	8	TGPS	PL
STN003	41PL-312-017	2016/146	546447	405093	19	TGPS	PL
STN004	41PL-312-018	2016/146	546296	404511	15	TGPS	PL
STN005	41PL-312-019	2016/146	546215	404128	21	TGPS	PL
PLL004	42PL-312-003	2016/146	550809	409353	26	TGPS	PL
GCM-1	71C20394	2016/191	457252	532329	-100	TGPS	nodef
36	12C50106	2016/230	595975	527554	-100	TGPS	nodef
PLL005	42PL-312-005	2016/146	550307	409649	32	TGPS	PL
BM-1	51TL-023-001	2015-199	510571	430556	45	TGPS	TL
BM10	91SL-420-041	2018-27	810582	425841	1	TGPS	SL
BM27	94TL-062-027	2017/67 & 2016/171A	691374	439229	38	TGPS	TL
BM-29	51TL-023-029	2015-199	497485	428034	11	TGPS	TL
6B	42C51850	2017/037	561014	408765	-100	T	nodef
11C1950	[illegible]	2016/209	647918	4594	-100		nodef
BM20		2017/67 & 2016/			49		TL

Etc., (total: 23,307 points)

[Figure Ⅱ-16] List of Control Points (Control Point Data Portal)

❍ Status of Continuous Observation Reference Station (CORS)-Network

– Sri Lanka established the CORS-Network installation plan in 2014 to enable real-time kinematic (RTK) through the installation of continuous observation reference station(CORS) in order to promote the universalization of GPS survey based on the national control point management system.

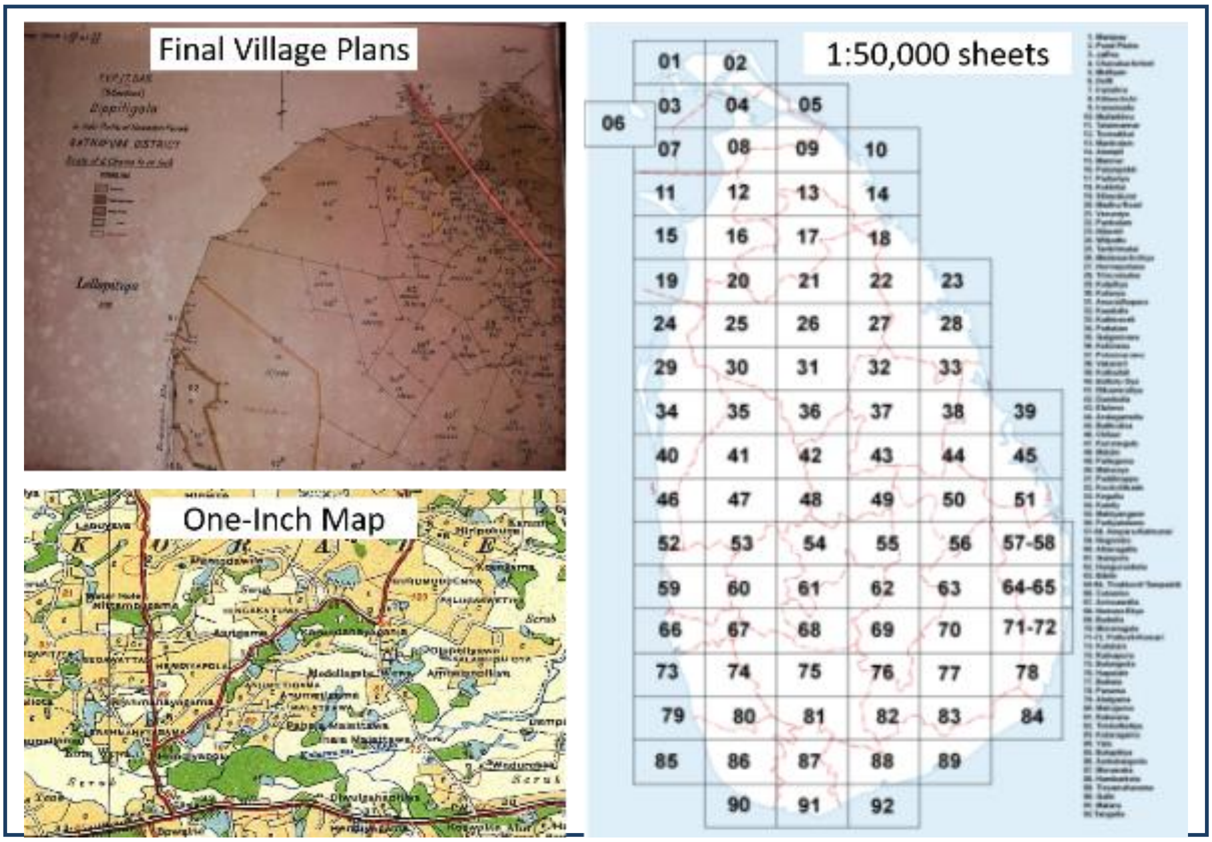
- Accordingly, in 2015, the pilot CORS-Network construction project was completed by installing 6 Continuous Observation Reference Station(CORS) centering in Western Province, and the Network RTK services have been provided in Western Province.
- The 6 CORS in Western Province have been installed in Colombo, Kalutara, Ratnapura, Avissawella, Kegalle and Katana as shown in the following figure. Each CORS is equipped with Topcon's GNSS receivers, choke ring antennae and Sri Lanka Telecom's VPN routers.

[Figure Ⅱ-17] Installation Status of CORS-Network in Western Province

3.6. National Base Map

❍ 1:50,000 Topographic Maps

- Sri Lanka introduced a one-inch map policy based on the final village plans (FVPs) in 1897 and managed the nationwide of Sri Lanka using 72 maps. The one-inch maps were updated based on FVPs over the course of 100 years from 1859 to 1958.
- It wasn't until 1978 that a 1:50,000-scale modern mapping which involves the use of the metric system by combining photogrammetric and cartographic techniques with the old one-inch map method was planned. Then, from 1979 to 1996, 92 map sheets of 1:50,000 topographic map of the nationwide of Sri Lanka were produced.
- In 1996, the 1:50,000 topographic map of the nationwide of Sri Lanka was completed, and it was based on this map that thematic maps reflecting various types of important national information were produced. Therefore, the 1:50,000 topographic map began to serve as a national base map.



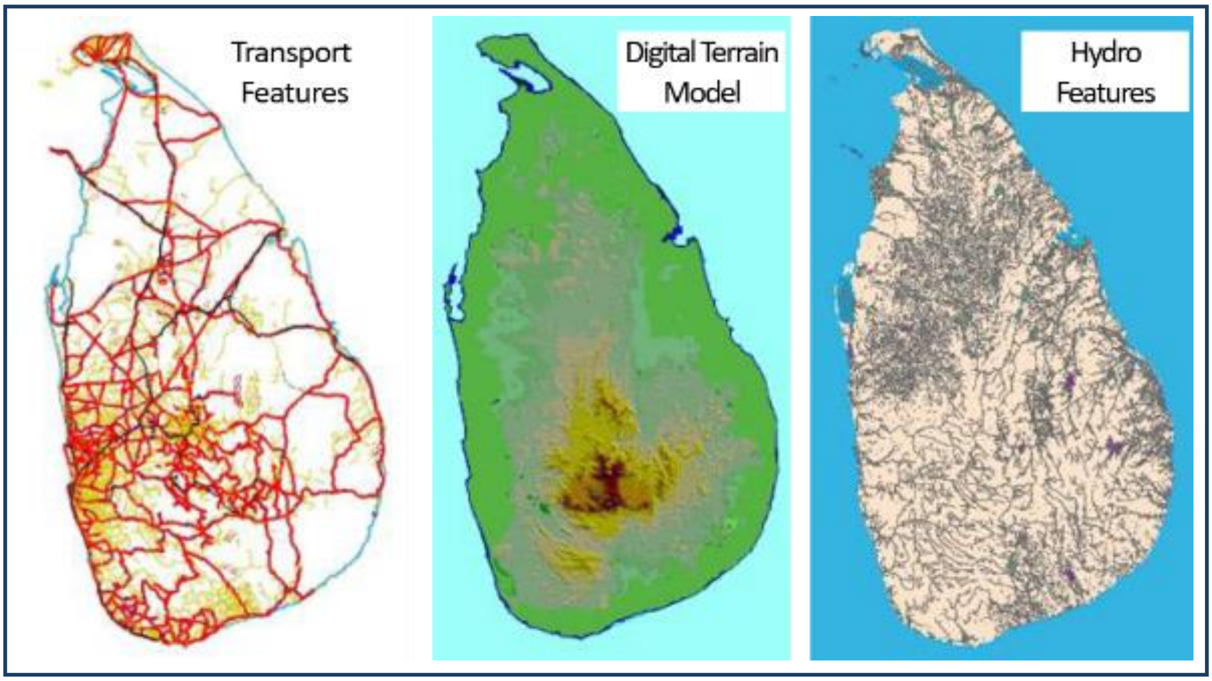
[Figure Ⅱ-18] One-Inch Map and 1:50,000 Sheets Based on FVP

❍ 1:50,000 Digital Topographic Map Database

– Starting from 1996, 1:50,000 topographic maps began to be digitized, and a 1:50,000 topographic map database for the nationwide of Sri Lanka is currently being provided to the general public. The topographic map database consists of Admin (DS Division), Buildings, Grid, Hydro (Streams, Tanks), Trans (Roads, Railroad), Landuse, Places, Reserves, Terrain (Contour, Spot Heights) and Utility (Power Line).

– Using the 1:50,000 topographic map database, various thematic maps (road network maps, digital terrain model (DTM), hydro, land use, geographical names, etc.) are produced and used in various administrative procedures.

– Sri Lanka's 1:50,000 digital topographic maps, topographic map database, and various thematic maps are continuously updated using Advanced Land Observing Satellite (ALOS) images.



[Figure Ⅱ-19] Production of 1:50,000 Thematic Maps

❍ 1:10,000 Digital Topographic Maps and Topographic Map Database

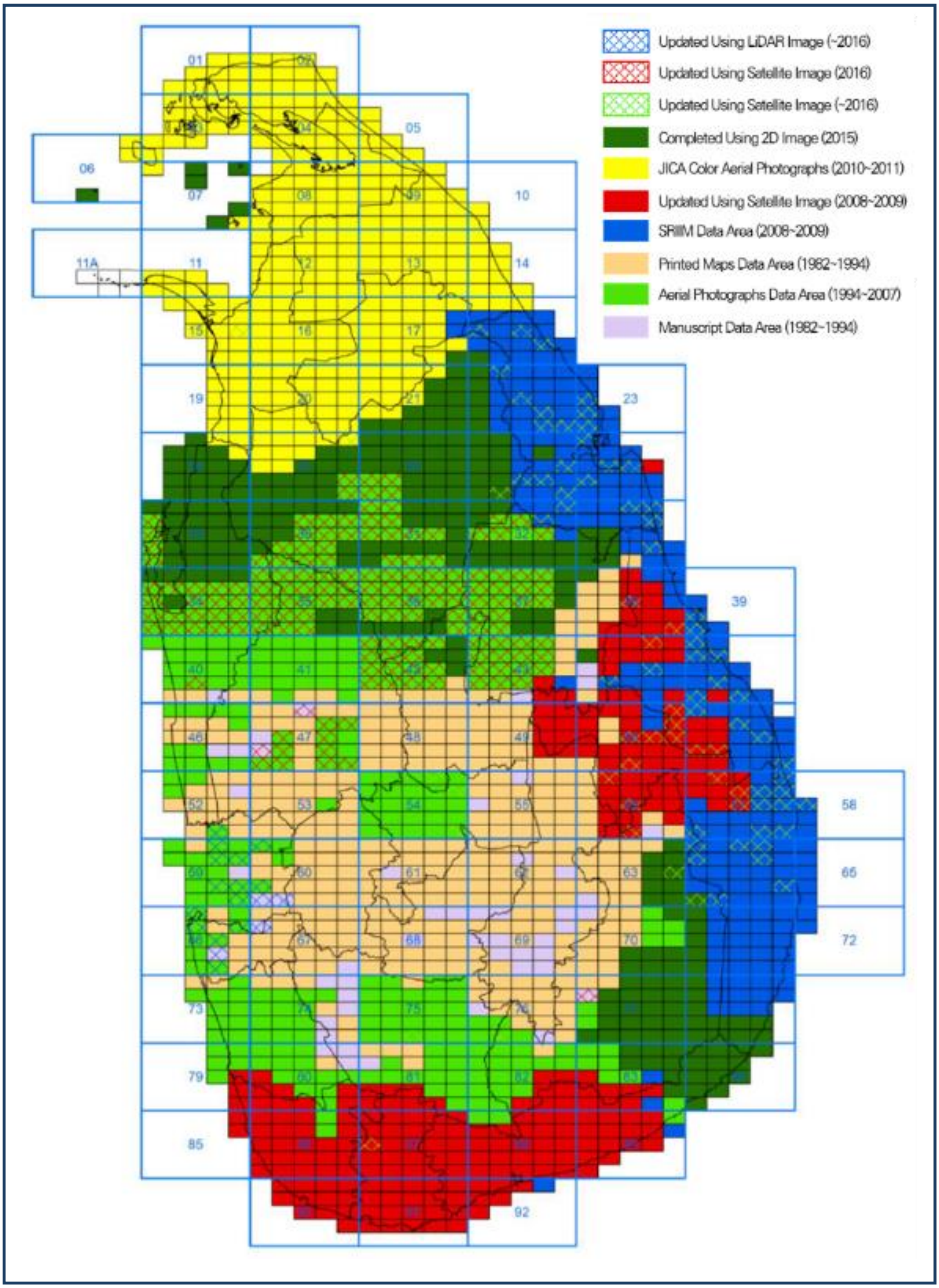
– In 1982, 1:10,000 digital topographic maps began to be produced in order to meet the demand for large-scale digital topographic maps. 1:10,000 digital topographic maps at the national level have been produced and updated using various source data.

– From 1982 to 1994, paper-based 1:10,000 topographic maps by field investigations have been produced, and digital topographic maps were produced based on aerial photogrammetry from 1994 to 2007.

– In 2008 and 2009, updates were made for some regions using images obtained from QuickBird, a high-resolution earth observation satellite. In 2010 and 2011, aerial photogrammetry using color images was conducted on Northern Province through JICA to produce 1:10,000 topographic maps.

– Since then, updates have been made for major areas through continuous high-resolution satellite imaging, and since 2016, the 1:10,000 digital topographic maps have been updated by aerial LiDAR surveys on Western Province.

– As of today, 1:10,000 digital topographic maps have been created at the nationwide of Sri Lanka, whereas the 1:10,000 topography database contains information on around 80% of the nationwide, except the areas mapped manually or as paper topographic maps (about 20%). The topography database is comprised of Admin Boundary (Up to GN Level), Construction (Buildings), Grid, Hydro (Streams, Tanks), Trans (Roads, Railroad), Land use, Toponomy and Utility (High Tension Power Line).

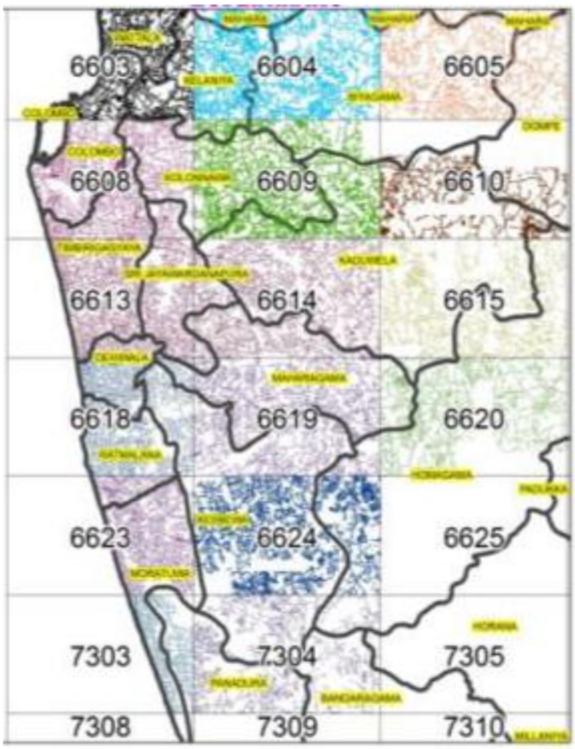


[Figure Ⅱ-20] Production of 1:10,000 Digital Topographic Maps

❍ 1:1,000 Digital Topographic Maps and Topography Database

– Currently, Sri Lanka has 1:1,000 digital topographic maps and topography database for only some parts of the Colombo Metropolitan Area. The topography database contains information in relation to Construction (Building), Hydro (Streams, Tanks), Land use, Terrain (Contour, Spot Heights) and Transport (Roads, Railroads).

– 1:1,000 digital topographic maps have been produced on a pilot basis through LiDAR surveys since 2016, but there are not yet any plans for nationwide application.



Construction (CO)	CO_Building_Pt
	CO_Builfing_Pg
Hydro (HY)	HY_Hydro_Pt
	HY_Hydro_Li
	HY_Hydro_Pg
Landuse (LU)	LU_Landuse_Pt
	LU_Landuse_Pg
	LU_Reserves_Pg
Terrain (TE)	TE_Terraing_Pt
	TE_Terraing_Li
Transport (TR)	TR_Transport_Pt
	TR_Transport_Li
	TR_Transport_Segment

[Figure Ⅱ-21] 1:1,000 Digital Topographic Maps and Topography Database

3.7. SLSDI Policy

❍ Background

– The National Spatial Data Infrastructure (NSDI) of Sri Lanka is the Sri Lanka Spatial Data Infrastructure (SLSDI), which was initiated in 2012 by the Minister of Land and Parliamentary Reforms (MoLPR) along with the relevant ministries. It was pursued with SDSL operating under MoLPR serving the role of a data provider.

– SLSDI has been pursued with the aim of achieving the vision of “Sustainable development through effective use of spatial information for evidence-based decision making,” and the objective of “creating a wide range of social benefits through efficient utilization and sharing of spatial data for business, research and innovation in the government and private sector.”

– Four main goals have been set forth to achieve the aforementioned vision and objective, and they are as follows:

① Goal 1 [Accurate national map coverage]

② Improve the accuracy and coverage of the Nation's spatial data so that it can be analyzed to address economic, social and environmental challenges.

③ Goal 2 [Greater efficiency and productivity in the management and sharing of spatial data]

④ To increase the efficiency and effectiveness of spatial data management through improved data sharing practices, open standards and an agreed policy framework.

⑤ Goal 3 [Spatial Solution widely available]

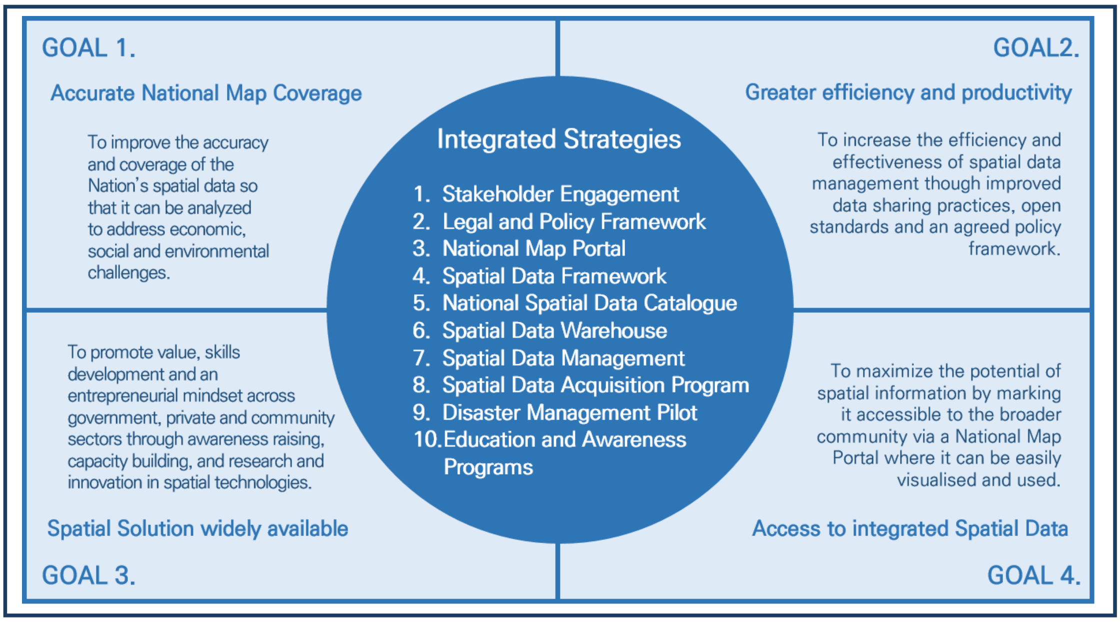
⑥ To promote value, skills development and an entrepreneurial mindset across government, private and community sectors through awareness raising, capacity building, and research and innovation in spatial technologies

⑦ Goal 4 [Access to integrated Spatial Data]

⑧ To maximize the potential of spatial information by marking it accessible to the broader community via a National Map Portal where it can be easily visualized and used

– In order to achieve the four goals, ten integrated strategies ranging from stakeholder engagement and legal and policy framework to education and awareness programs have been developed and are being implemented.

– The relationships between the four goals and the ten integrated strategies for SLDSI are as follows:

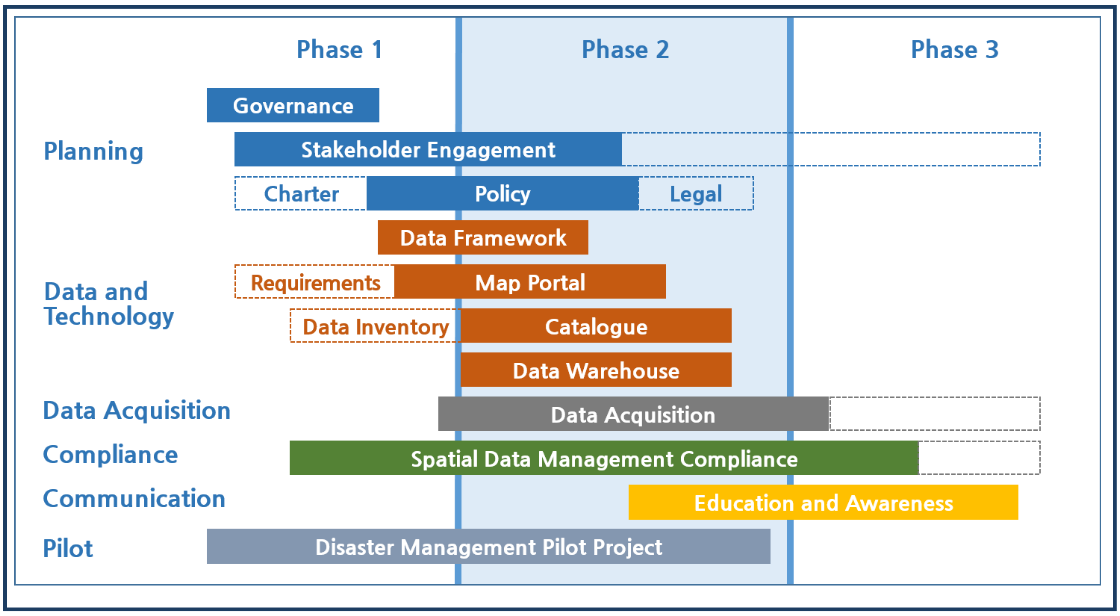


[Figure Ⅱ-21] 4 Goals and 10 Integrated Strategies for SLDSI

❍ SLSDI Roadmap[19]

– Sri Lanka has established a three-phase roadmap by dividing the 10 integrated strategies into planning, data and technology, data acquisition, compliance, education and awareness, and disaster management pilot project.

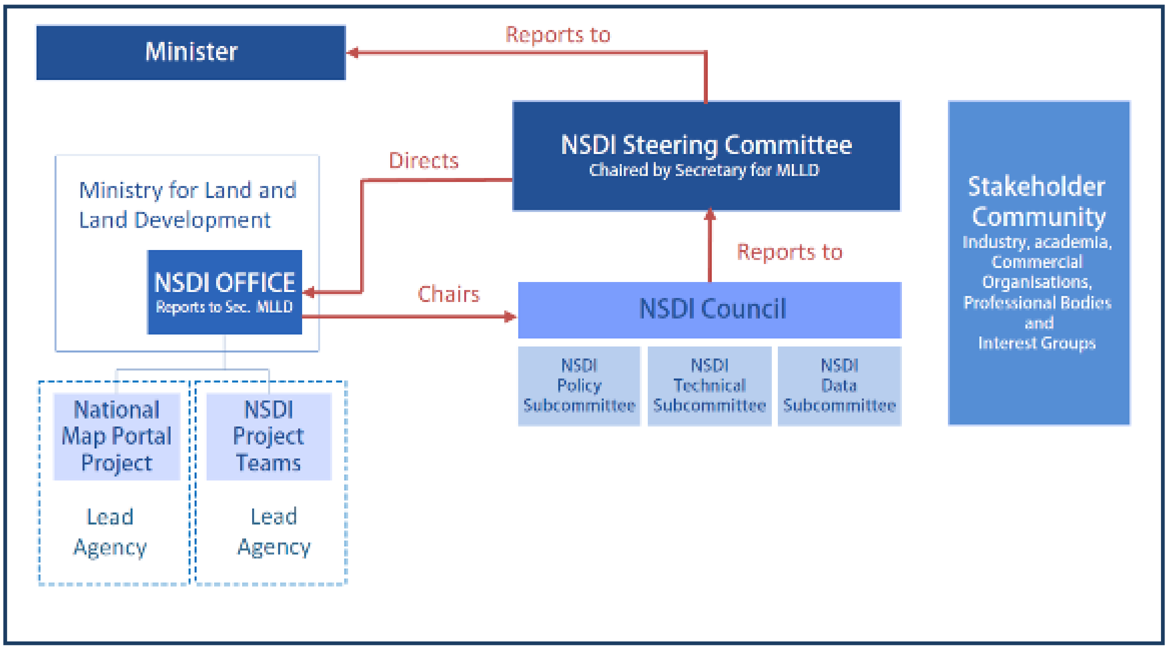
19 Referenced to Consultation Document for Spatial Data Infrastructure Strategy 202



[Figure Ⅱ-22] SLDSI Roadmap

❍ SLSDI Governanc[20]

– SLSDI is divided into NSDI Office and NSDI Council centering around the NSDI Steering Committee. The NSDI Office is further divided into National Map Portal Project and NSDI project teams and the NSDI Council is composed of sub-committees for policy, technology and data.



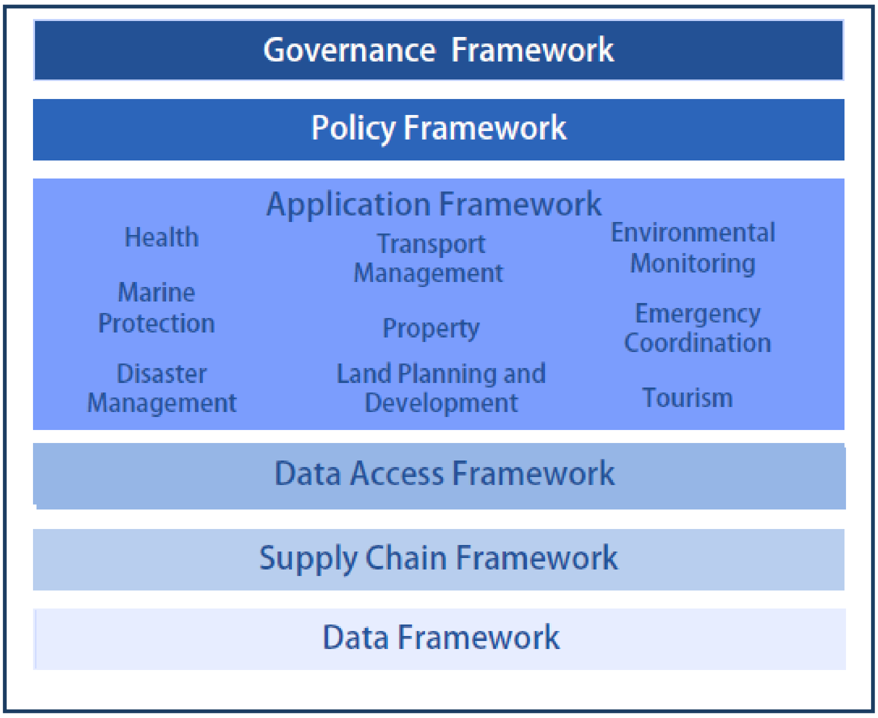
[Figure Ⅱ-23] SLDSI Governance Model

20 Referenced to Consultation Document for Spatial Data Infrastructure Strategy 202

❍ SLSDI Framework[21]

- SLSDI consists of six frameworks: of a data framework, supply chain framework, data access framework, application framework, policy framework, and governance framework.
- The data framework provides a way to organize the map content to facilitate management by data administrators and system administrators and access by users.
- It also defines the data standards used and the scope of application for each data set and provides a function for producing and managing metadata for data management.
- The supply chain framework provides data to entities that need spatial data, provides resources necessary to use the service, and includes the process of converting raw data into data for distribution.
- The data access framework provides the function to access spatial data managed by various entities through an integrated spatial information portal and provides a common development framework for developing application programs that utilize spatial data.
- A key element of the data access framework is the National Map Portal, which provides access to the spatial data layer, and the system architecture consists of users, security, integration, application programs, key services, and management layers.
- The application framework is comprised of purpose-specific systems using services and spatial data sets made available through the data access framework. It includes various thematic applications such as disaster management, environmental monitoring, tourism, and resource management.
- The policy framework includes legislative and policy measures to achieve SLSDI and includes policies and guidelines for spatial data collection and management, data access, pricing, privacy, data security and intellectual property management.
- The governance framework includes comprehensive adjustments for SLSDI to allow various government agencies to share spatial data and improve the processes of each agency as well as adjustments at the national level for all stakeholders to understand and accept SLSDI.

21 Referenced to Consultation Document for Spatial Data Infrastructure Strategy 202



[Figure Ⅱ-24] SLDSI Framework Composition

3.8. Organizations and Tasks Related to National Spatial Information

❍ The organizations related to national spatial data in Sri Lanka include entities necessary for national land development and conservation, national spatial data acquisition and management, and land registration and management centering on the Ministry of Lands and Parliamentary Reforms (MoLPR).

❍ The department concerned with national land planning and conservation within MoLPR is the Planning Division, and it is under the supervision of the Department of Land Commissioner General's and the Land Use Policy Planning Department.

❍ The Department of Land Settlement of the Land Division is in charge of affairs pertaining to land, while the Survey Department is responsible for acquisition of land information.

❍ The registration of land title is based on collaboration between departments through the Land Title Registration Program (Bim Saviya).

❍ Acquisition and management of national spatial data including national land information is carried out under the direction of SDSL. Various types of national spatial data are jointly used by central government agencies and local governments through the stakeholders of SLSDI.

❍ Also, updates to national land information are to be made in a complementary manner through cooperation among the Urban Development Authority (UDA), Road Development Authority (RDA), and SDSL under MoLPR through joint use and development of land information; however, due to the absence of a national spatial data distribution system (system for joint use), seamless cooperation has not been possible.

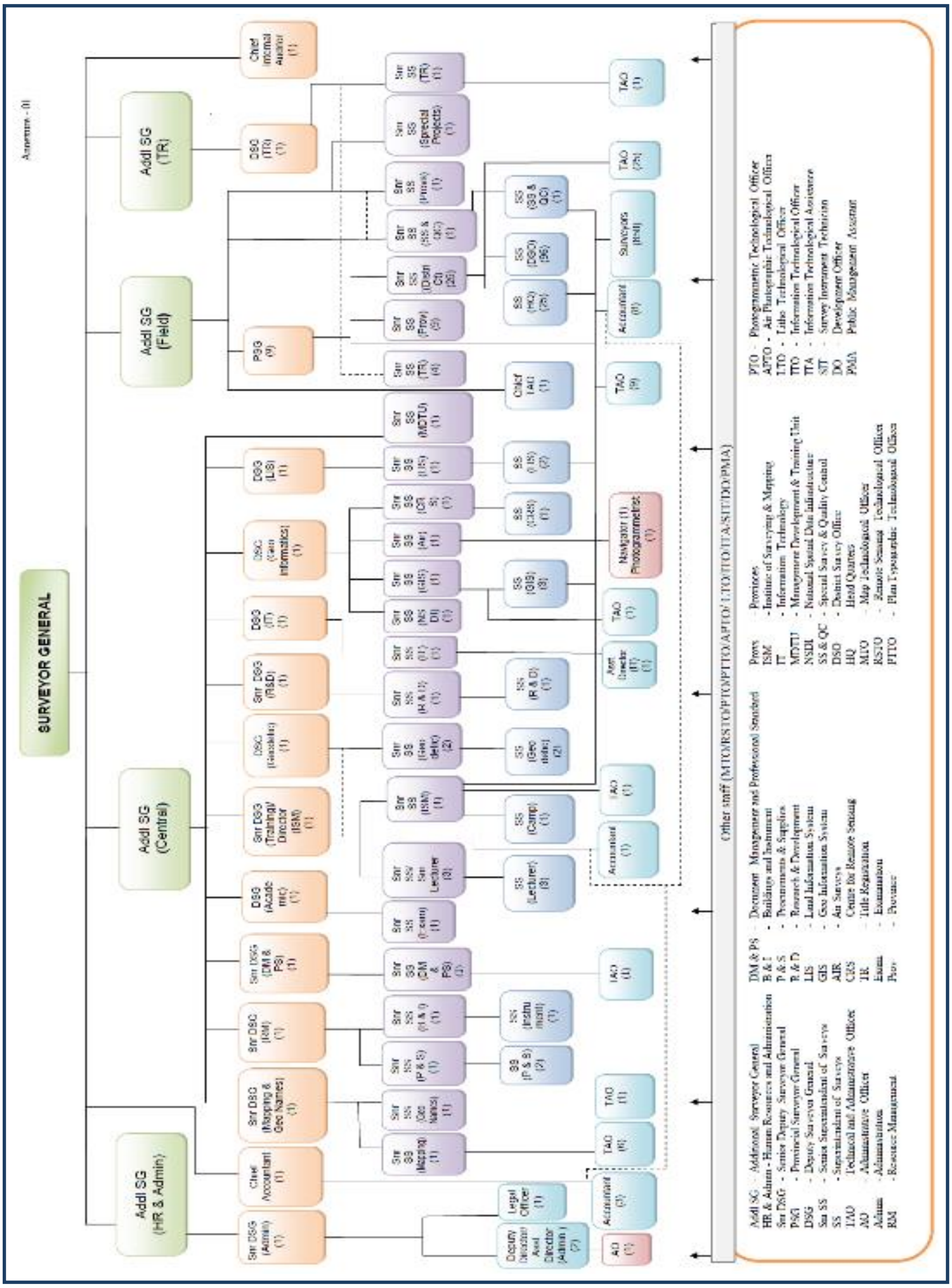
❍ SDSL, which is responsible for supervising the acquisition and production of national spatial data in Sri Lanka, is comprised of entities that produce and manage national spatial data accompanied by surveying such as national control point management, production of digital topographic maps and various thematic maps, satellite image-based mapping, land surveying and land information system establishment.

❍ SDSL Organization and Responsibilities

- SDSL is composed of the head of SDSL (Surveyor General), Additional Surveyor General responsible for manpower management and administration, Additional Surveyor General responsible for the production and management of spatial data, Additional Surveyor General responsible for the management of regional offices, and Additional Surveyor General responsible for land title registration.
- The Additional Surveyor General responsible for the production and management of spatial data oversees departments in charge of geodetic and control points, mapping and geographical names, NSDI, document management and standards, geoinformatics, land information, information technology, resource management, education, and research and development (R&D).
- The department in charge of geodetic and control points oversees tasks concerning management of national control points and CORS-Network, GPS survey, leveling, gravity survey, and setting up various control points under the responsibility of the Senior Deputy Surveyor General.
- The department in charge of mapping produces and updates 1:50,000 topographic maps and produces special maps and thematic maps under the responsibility of the Senior Deputy Surveyor General.
- The department responsible for managing geographic names oversees tasks related to geographic names and defining the national data system pertaining to the cultural heritage of the Sri Lankan people.
- The NSDI department is responsible for tasks related to spatial data conversion, NSDI feature catalog and NSDI website for joint use by relevant entities.
- The department responsible for document management and standards is in charge of managing the old survey plans and preliminary tasks in accordance with the use of the old plans and for updating the old survey plans including issuing copies of the title plans.
- The geo informatics department is comprised of an air survey branch, remote sensing branch and GIS branch. The Air Survey Branch produces and updates 1:10,000 digital topographic maps by aerial photogrammetry, manages and distributes aerial photographs, produces DEM based on aerial LiDAR survey, and revises and updates 1:10,000 digital topographic maps.
- The Remote Sensing Branch is in charge of revising and updating 1:50,000 topographic map using satellite imagery and producing land cover maps.
- The GIS Branch is in charge of building and updating a topography database for 1:50,000 digital topographic maps and for 1:10,000 digital topographic maps each.

– The LIS department is in charge of performing cadastral surveys, sporadic surveys, and field survey for parcel, real estate and forests. It is also in charge of overseeing the land information system and providing land-related information.

– The education-related department is in charge of training surveyors and other human resources for production and management of spatial data, while the R&D department is in charge of introducing new technologies for the production and management of spatial data.



[Figure Ⅱ-25] SDSL Organization Chart

3.9.Survey Fees and Surveyors

❍ In Sri Lanka, the first survey is performed free for land registration purposes, but fees are charged for subsequent surveys (survey for development such as land subdivision and merger).

❍ The services provided by SDSL consist of land information service, geo information service, andgeodetic survey service. Fees are imposed according to the level of difficulty of the work performed and the work process.

[Table II-21] Survey Fees Charged by SDSL

Type of work	Amount of fees Rs.
Setting out of a control point in 3rd class using satellites. Minimum survey fee is Rs. 60,000.00	
For one point, for setting out scattered points as a single point	20,000.00
Sets of points in 3 points each available in order	
For one point, for the first 10 point sets (30 points)	16,000.00
For one point for the second 10 point sets (30 points)	14,000.00
For one point, when more than 20 point sets (60 points)	12,000.00
Carrying out of surveys using real time kinematic satellite technology. Minimum survey fee is Rs. 100,000.00	
For one point for first 100 points	1,000.00
For one point, from number of points 100 to 200	900.00
For one point, from number of points 200 to 300	800.00
For one point, from number of points 300 to 400	700.00
For one point, when number of points exceeding 400	600.00
Geodetic leveling. Minimum survey fee is Rs. 50,000.00	
For 1 km for level lines in second class (to both directions)	25,000.00
For 1 km for level lines in third class	15,000.00
For 1 km for level lines in detail and minor class	12,000.00
Control traverses. Minimum survey fee is Rs. 50,000.00	
For 1 km of total station survey traverses in first order	100,000.00
For 1 km of total station survey traverses in second order	80,000.00
For 1 km of total station survey traverses in third order	60,000.00
Setting out of Ground Control Points. Minimum survey fee is Rs. 50,000.00	
For one point, for identification of control points - selection	5,000.00
For one point, for setting out of horizontal coordinates using satellites	15,000.00
For one point, for setting of vertical coordinates using satellites	30,000.00

❍ In addition to the survey services of SDSL, various other types of survey work for land registration, construction, etc. are carried out, and the fees charged by survey companies are around two-thirds that of the fees charged by SDSL.

[Table II-22] Survey Fees (SDSL Rate and Market Rate

Survey Task (Category)	SDSL Rate	Market Rate
Establishment of GPS Static control point (Type B) 1:50,000	30,000	20,000
Establishment of GPS Static control point (Type C) 1:20,000	25,000	16,500
Establishment of RTK point (Per point)	10,000	7,000
Reopening points	10,000	7,000
Survey and attribute data collection of Land Parcels		
For 8 perch	5,000	3,500
Within 8~20 perch	6,500	4,500
Within 20~40 perch	8,000	5,500
Within 40~80 perch	10,500	7,500
Within 80~160 perch	12,000	8,500
Within 160~200 perch	13,500	9,500
Within 200~240 perch	15,000	11,500
Within 240~280 perch	16,500	12,500
Within 280~320 perch	18,500	13,500
Within 320~400 perch	19,500	15,500
Detailed Survey of Roads (20m width)		
Within padeshiys Saba (For 1km)	500,000	350,000
Within Urban Council area (For 1km)	700,000	400,000
Setting out of a center line of a road	40,000	30,000
Control point accuracy verification (per point)	10,000	7,000

❍ The survey companies in Sri Lanka specialize in general survey or a series of processes ranging from national spatial data production to processing such as GIS databaseconstruction.

❍ As of May 2019, there are around 230 registered survey companies in Sri Lanka, and most of them perform general survey for construction and land registration (http://www.landsurveycouncil.org/).

❍ Some of the registered survey companies perform a series of tasks related to the acquisition of spatial data such as satellite image mapping, UAV survey, ad control point survey, and these companies develop and distribute GIS application programs using an open source.

❍ Survey Council was established to protect the rights of surveyor. It has been established in accordance with Article 17 (27) of the Survey Act revise in 2002.

❍ The Land Survey Council has been established with the vision of “enhancing the environment for professional survey services in the global market by maintaining the integrity of regulations for land survey and ensuring sustainable use of internal resources for national development.” Its objective is “to ensure that surveyors comply with the professional ethics as the most professional code of conduct and reinforce their expertise through education and training in the latest survey techniques.”

❍ The Land Survey Council has the ultimate goal of raising the technical competitiveness of the domestic surveyors through ongoing education and training while protecting their rights and interests.

❍ One must complete the periodic education and training provided on the latest survey technology in order to be registered as a licensed surveyor with the Land Survey Council. The Land Survey Council provides information on licensed surveyors every year.

All surveyors in Sri Lanka are required to be licensed by Land Survey Council before they can carry out survey work. Currently, there are 2,181 licensed surveyors in Sri Lanka (http://www.landsurveycouncil.org/).

No	S/No	Registration No	Name	Full Name	Registered Date
1	165	19680165	ABAYASIRI N.	Nandasena Abayasiri	04th October, 2002
2	6	19670006	ABDEEN M.Z.	Mohamed Zainul Abdeen	04th October, 2002
3	1554	19891554	ABDUL GAFFOOR M.M.	Meerashahib Mohamed Abdul Gaffoor	28th February, 2008
4	1848	20081848	ABESIRIGUNAWARDHANA	Chulanga Sarath Kumara Abesirigunawardhana	26th December, 2011
5	675	19680675	ABEYAGUNAWARDENE C.H.D.	Calyanapriya Hemasiri Dias Abeyagunawardene	04th October, 2002
6	417	19680417	ABEYARATNE A.	Ariyasena Abeyaratne	04th October, 2002
7	110	19680110	ABEYARATNE S.	Sugathapala Abeyaratne	04th October, 2002
8	1767	20081767	ABEYGUNAWARDANA C.S.	Chanaka Sampath Abeygunawardana	30th July, 2010
9	23	19700023	ABEYGUNAWARDANA D.U.	Don Upali Abeygunawardana	04th October, 2002
10	299	19990299	ABEYGUNAWARDANA P.M.	Prasanna Mangala Abeygunawardana	04th October, 2002
11	704	19480704	ABEYGUNAWARDENA A.R.D.	Ariyananda Rabindranath Dias Abeygunewardene	04th October, 2002
12	621	20020621	ABEYGUNAWARDHANA G.	Gunasha Abeygunawardhana	04th October, 2002
13	680	19900680	ABEYKOON D.R	Dahanaka Rallage Abeykoon	04th October, 2002
14	2014	20112014	ABEYKOON N.D.	Nalin Dhammika Abeykoon	06th June, 2014
15	476	19870476	ABEYKOON P.J.K.	Pemadasa Jalath Kankanam Abeykoon	04th October, 2002
16	468	19820468	ABEYKOON R.B.	Ram Banda Abeykoon	04th October, 2002
17	30	19770030	ABEYKOON S.B.	Sumanaratne Bandara Abeykoon	04th October, 2002
18	1186	19871186	ABEYKOON S.K.	Sunethra Kumari Abeykoon	24th August, 2007
19	1720	19871720	ABEYRATHNA C.B.	Carmalin Bernadatte Abeyrathna	22nd September, 2009
20	1830	19921830	ABEYRATHNE R.M.S.N.	Rathnayaka Mudiyanselage Shirani Nilmini	30th September, 2011
21	3	19690003	ABEYRATNA H.B.	Herat Banda Abeyratna	04th October, 2002
22	949	20010949	ABEYRATNE P.G.V.	Pihillagawa Gedara Vipula Abeyratne	15th July, 2005
23	499	19670499	ABEYRATNE S.M.	Samarakone Mudiyanselage Abeyratne	04th October, 2002
24	1477	19971477	ABEYSEKARA D.C.V.	Dayan Che Vijith Abeysekara	23rd November, 2007
25	1867	19891867	ABEYSEKARA G.M.	Gajanayaka Mudiyanselage Abeysekara	09th February, 2012
26	182	19630182	ABEYSEKARA W.C.S.M.	Walimuni Croesus Somaratne Mendis Abeysekera	04th October, 2002
27	1941	20121941	ABEYSEKERA C.S.	Chinthana Srimal Abeysekera	13th March, 2013
28	1539	20011539	ABEYSINGHA T.U.K.	Tilak Upul Kumara Abeysingha	28th February, 2008
29	1635	19991635	ABEYSINGHE A.M.L.T.	Abeysinghe Mudiyanselage Lalith Thushara	30th May, 2008
30	1059	20001059	ABEYSINGHE H.	Henry Abeysinghe	20th March, 2007
31	368	19860368	ABEYSINGHE R.T.	Raja Thilak Abeysinghe	04th October, 2002
32	195	19900195	ABEYSINGHE S.B.	Samarakoon Bandara Abeysinghe	04th October, 2002
33	281	19740281	ABEYSIRIWARDENA S.	Sirisena Abeysiriwardana	04th October, 2002
34	240	19740240	ABEYSUNDARA D.H.B.	Dhammaratne Heen Banda Abeysundara	04th October, 2002
35	96	19820096	ABEYSUNDARA S.	Sunimal Abeysundara	04th October, 2002
36	474	19680474	ABEYSUNDARA W.	Wilmot Abeysundara	04th October, 2002
37	260	19690260	ABEYWARDHANA D.D.Y.	Don David Yapa Abeywardhana	04th October, 2002
38	1	19740001	ADHIHETTY C.D.	Chitrasoma Dharmasiri Adhihetty	04th October, 2002
39	2157	20172157	ADHIKARI A.M.H.V.	Adhikari Mudiyanselage Hashika Viranjani Adhikari	27th September, 2018
40	2138	2017[illegible]38	ADHIKARI A.M.J.P	Adikari Mudiyan[illegible] Janith Prasanna Adikari	[illegible]th July, 2018
41	2012	[illegible]	ADIKARAM A[illegible]	Adikari M[illegible] Adikaram	[illegible] 2014

Etc., (total: 2,181 persons)

[Figure Ⅱ-26] Licensed Surveyors in Sri Lanka

4. Implications

4.1. Socioeconomic and Policy Aspects

- ❍ The biggest industry in Sri Lanka is the service industry at 62.5% followed by manufacturing at 29.7% and agriculture at 7.8%, with the promotion of dramatic growth of the secondary and tertiary industries; however, Sri Lanka lacks competitiveness on the international stage and is striving to attract foreign investment.

- ❍ Most of the new projects related to social overhead capital (SOC) such as roads, ports, urban development, housing construction, water supply and sewerage are being carried out through overseas investment. Secondary economic growth through promotion of land transactions is being pursued in order to improve the efficiency and value of foreign investment.

- ❍ With the vitalization of the market economy and an increase in economic activity through land ownership and land value, there is a need to raise the efficiency of land-related administrative processes and to establish the related public service systems.

- ❍ In the case of promoting land transactions, its reliability may be guaranteed by ensuring clear land information, and the industrial structure can be made more sophisticated through comprehensive management, development, and conservation of land by ensuring transparent land transactions.

- ❍ In order to promote transparent and effective administration and financial soundness, efforts are being made to strengthen the macroeconomic framework, and to this end, improving government operations has been made a top priority in the e-Sri Lanka initiative.

- ❍ 30 major tasks have been establishe to improve public services through the means of improving government operations, and at the same time, the Provincial Land Management System (PLIS) is expected to enhance the administrative capacity and financial soundness and create opportunity cost for the public.

- ❍ Above all, what is being stressed the most from the socioeconomic and policy aspects is to achieve financial soundness by promoting land transactions and ensuring their transparency and at the same time to pursue secondary economic revitalization through land transactions and reinforce the administrative capacity to support this pursuit.

4.2. ICT Aspect

- ❍ With respect to ICT, the government of Sri Lanka is encouraging the use of digital technology and other emerging technologies to enable the nation to gain competitiveness amidst the increasingly digitalized global economy through Vision 2025, and through this, it is seeking to reduce various costs, achieve integrated growth, and create new jobs under a more powerful digital system.

❍ To this end, steps have been taken to secure a national digital identity, and focus has been on creating a digital environment where the document signature and spending processes are digitalized and where safe and efficient transactions and government information management can be possible.

❍ The government is encouraging the introduction of foreign high-end technologies and innovative technologies to strengthen the capacity to manage national intellectual properties.

❍ Sri Lankans' understanding of IT was low in 2016 at 27.5%, and the home Internet penetration rate was also low, with only 15.1% of the households having Internet access at home. However, an understanding of ICT has been incorporated into the regular curricula and the critical technical infrastructure necessary to deliver ICT to the younger generations is being provided in order to create a powerful digital economic environment.

❍ Even in the aspect of improving utilization of e-Government, there are plans to provide a larger number of free Wi-Fi networks and wider Internet access.

❍ There are plans to launch smart social and civic capacity building programs and provide efficient grassroots-level services demanded by citizens through e-Grama Niladari.

❍ This series of government activities is in line with the target model for providing public or government services through the sharing of land information accumulated through the establishment of Sri Lanka Land Information System (LIS) and the secondary processing of the information.

❍ In addition, there are plans to lay down and strengthen the legal foundation for electronic transactions and it is expected that the business model will be promoted in the e-Commerce industry base established through the electronic transactions bill (amended).

4.3. National Land Information Aspect

❍ Although land information has been managed since 1800 in Sri Lanka, but it does not reflect the process of acquiring land information and the development of management technology. the government has failedto keep up with the pace at which the technology for acquiring and managing land information. Therefore, there is a lack of basic data for promoting policy-based land transactions.

❍ Building and providing quality land information to reinforce the macroeconomic framework is needed most urgently than anything else, and while Sri Lanka has been making its own efforts to achieve this, it has been failing to attain its goal because its basic infrastructure is insufficient.

❍ This has led to inadequate international competitiveness in the field of national land information, and in order to overcome this, it has become necessary to lay the groundwork first using foreign investment or loan.

❍ Laying the groundwork with foreign investment or loan can help reinforce the macroeconomic framework of the Sri Lankan government only if the focus is place on modernizing land infor mation (drawings and registers), systematizing land-related administrative processes, ensuring co nsistency with the national spatial data, and preparing a system for joint use of land-related info rmation.

❍ The government of Sri Lanka is striving toward a vision of “Sustainable development through effective use of spatial information for evidence-based decision making,” and efforts are being made to improve awareness of spatial data technology, pursue capacity building, and raise the value of spatial data across society through research and innovation.

❍ This type of national spatial information system will lay the groundwork for core national projects with objectives ranging from joint utilization of land information to national land information management, national land development and conservation, and disaster management.

❍ To promote land transactions from the socioeconomic aspects, the macroeconomic framework promoted at the policy level is developing into a public service that reflects the direction of ICT development based on information on the national land including land information.

❍ The national land information and national spatial information system based on the land information of Sri Lanka is becoming a major national project that I beyond the social, economic, and policy levels and is expected to play a major role in pump-priming the economy in the future.

Ⅲ. Object Project Analysis

1.Analysis of Land and Spatial Information DB

1.1.Analysis of Old Survey Plans

❍ The current status of Sri Lanka's land plans can be classified as a Survey Plans and Title Plans to register title on national and private land, and Survey Plans and Title Plans have been underway since 1800 and are called Old Survey Plans.

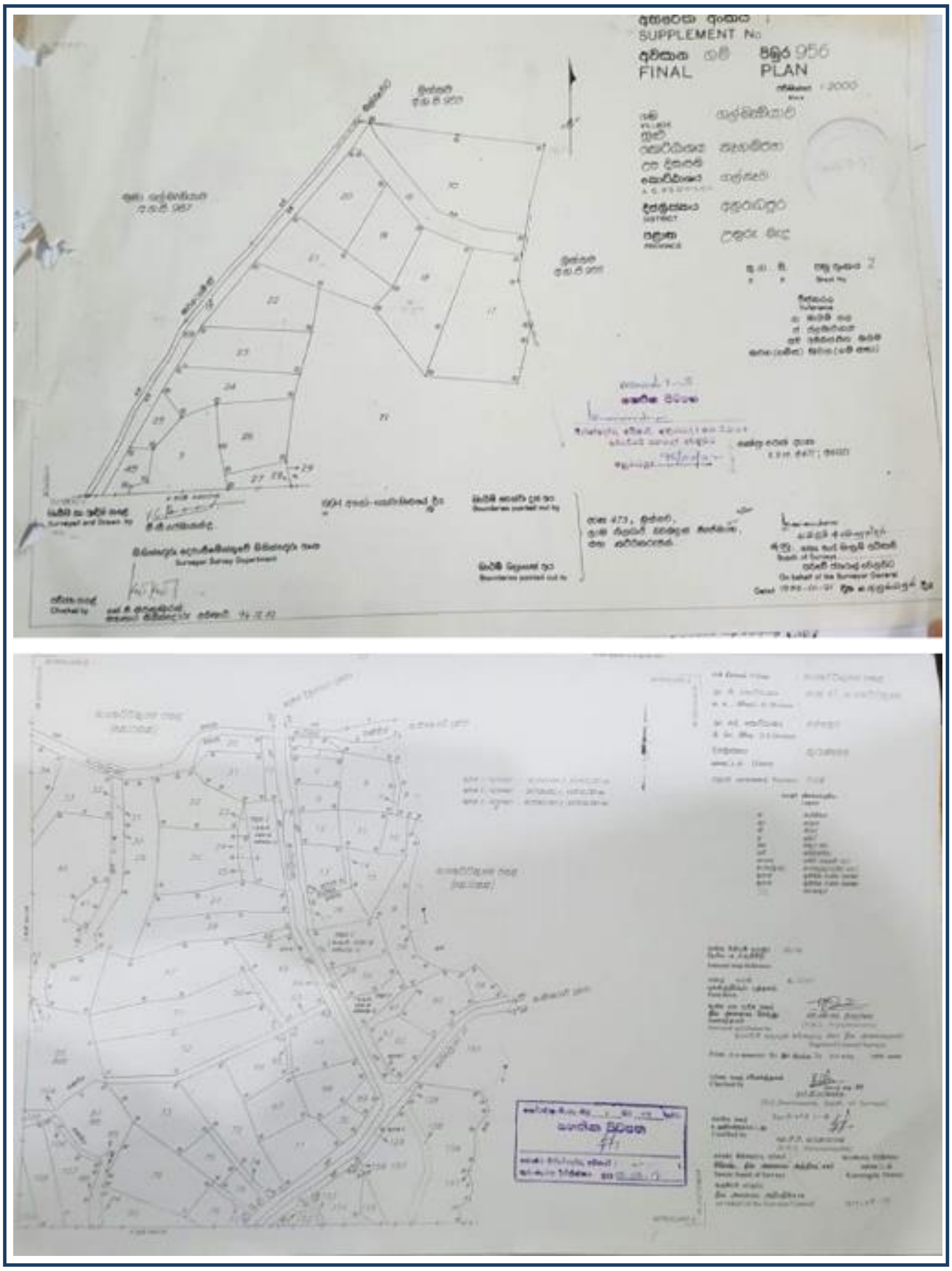
❍ Currently, the type of Old Survey Plans being stored and managed by the Survey department of Sri Lanka is Preliminary Plans, which is a part of the Survey Plans conducted to transfer state-owned land to the private sector, Final Village Plans (FVP), which is a survey of land at the village level, and the Topographic Survey Preliminary Plans (TopoPP) based on sporadic land volumes in rural or forest areas.

[Table Ⅲ-1] Old Survey Plans Status

Provinces	FVP	ToppPP/FTP	PPA	PP	Total
WP	149	3	5,424	20,430	26,006
NWP	4,002	31	1,880	7,770	13,683
NP	143	80	2,499	8,430	11,152
CP	639	28	3,193	9,260	13,120
NCP	1,756	27	156	7,870	9,809
EP	58	55	1,469	6,840	8,422
SP	665	5	2,121	14,470	17,261
SAB.P	955	10	1,248	4,190	6,403
UVA.P	680	80	386	2,990	4,136
Total	9,047	319	18,376	82,250	109,992

❍ The Preliminary Plans were named PPA for the land survey results established in 1956. From then until now, the District Code was imposed and classified as PP managed by the district survey office.

❍ Currently, Sri Lanka has implemented the Bim Saviya Programme, a new land title certificate, through land survey performance verification, and is using Survey Plan as the basic information for field survey performance verification, but the information is not computerized, making it difficult to prepare for the survey and utilize it in field surveys.



[Figure Ⅲ-1] Preliminary Plans

❍ Survey Plans, which are subject to the computerization of existing cadastral map, are managed by district survey office. Currently, all Survey Plans are scanned, but has the time, cost and basemap issues to geo-reference and digitize it.

[Table Ⅲ-2] Survey Plans scanned by District Survey Office

Provinces	District Name	Total		Digitizing (2019. 05)	
		No of Plans	No of Lots	No of Plans	No of Lots
Western Province	KALUTARA	4,615	116,944	78	103
	COLOMBO	9,633	12,500	1,650	854
	GAMPAHA	8,371	0	1,744	1,002
North-Western Province	KURUNEGALA	8,820	349,060	4,327	213
	PUTTALAM	370	75,368	899	10,849
North Province	JAFFNA	2,856	30,246	385	1,996
	VAVUNIYA	416	52,687	411	6,700
	MANNAR	782	16,673	348	3,960
	MULATIVU	294	24,767	210	4,725
	KILINICHCHI	562	24,900	672	12,689
Central Province	KANDY	6,262	162,707	3,825	12,822
	MATALE	2,225	120,227	1,504	1,023
	NUWARAELIYA	2,759	70,356	317	30
North-Central Province	ANURADAPURA	2,212	514,464	1,759	2,893
	POLONNARUWA	689	253,492	467	6,805
Eastern Province	TRINCOMALEE	3,230	89,190	917	16,383
	BATTICALOA	2,797	12,098	512	1,420
	AMPARA	4,081	171,434	1,890	9,910
Southern Province	GALLE	6,026	114,321	1,463	932
	MATARA	2,798	95,423	799	0
	HAMBANTOTA	724	188,862	0	1,037
SABARAGAMUWAI Province	KEGALLA	9,670	77,373	1,131	0
	RATNAPURA	1,116	388,887	275	0
UVA Province	BADULIA	458	176,814	408	963
	MONARAGALA	537	136,829	1,095	4,140
TOTAL		82,303	3,275,622	27,086	101,449

❍ Currently, there are three major geo-referencing methods defined in the Sri Lankan Survey Department.

① Method for geo-referencing using coordinates written in Survey Plans
② Method of geo-referencing based on the base map officially provided by the District Survey Office
③ After perform a direct survey on the boundary point or boundary marker, method of geo-referencing using coordinates by direct survey

❍ Geo-referencing method using coordinate by direct survey may maintain the highest accuracy, but it takes a lot of time and money. Need to establish a more effective methodology.

❍ Thus, the scanned Old Survey Plans can be computerized more effectively if the Old Survey Plans are geo-referenced based on high-resolution satellite images of the nationwide.

1.2.Analysis of existing LIS DB

❍ The implementation of the new Land Certificate Issuing System, the Bim Saviya Programme, involves the final parcel boundary determination by re-survey of existing Survey Plans. Through such work, create a Numeric Cadaster and build an Land Information System (LIS) database.

❍ The number of numeric cadaster, which is aggregated into the LIS department of the Survey Department of Sri Lanka through the Bim Saviya Programme, is approximately 150,000 parcels a year. The LIS databases, built with numeric cadaster by May 2019, has 1,384,413 parcels, which is not possible for 5.82% of the total national territory.

[Table Ⅲ-3] LIS DB Status Due to Numeric Cadaster (2019 May Standards)

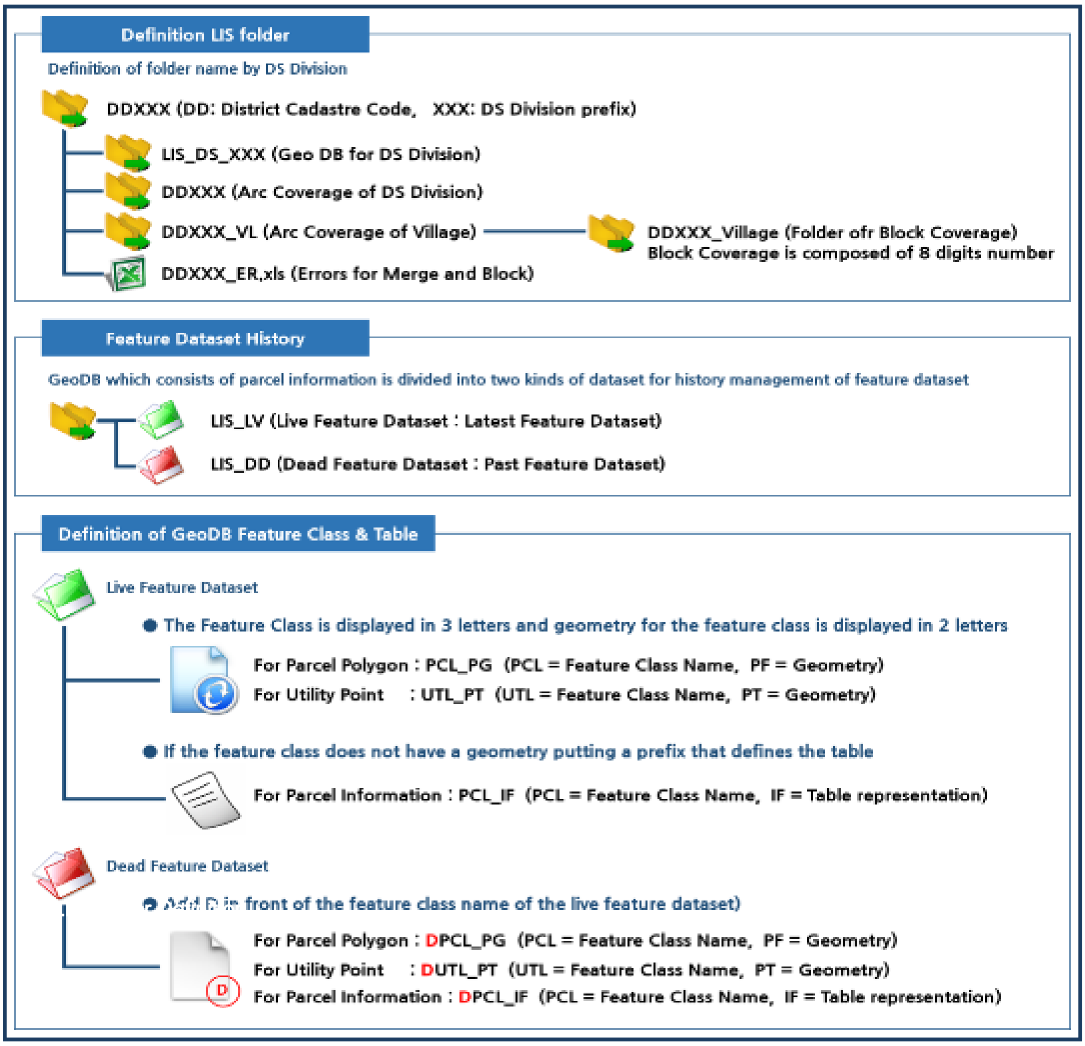
Provinces	District Name	No. of lots	Area of DB (㎢)	Rate(%)
Western Province	KALUTARA	43,165	37	2.35
	COLOMBO	221,440	132	19.53
	GAMPAHA	276,850	455	33.93
North-Western Province	KURUNEGALA	110,398	238	5.15
	PUTTALAM	28,279	44	1.53
North Province	JAFFNA	5,389	3	0.32
	VAVUNIYA	15,467	59	3.17
	MANNAR	8,508	19	1.01
	MULATIVU	20,684	55	2.28

Provinces	District Name	No. of lots	Area of DB (㎢)	Rate(%)
	KILINICHCHI	18,124	52	4.32
Central Province	KANDY	90,427	104	5.43
	MATALE	45,997	168	8.61
	NUWARAELIYA	12,465	38	2.23
North-Central Province	ANURADAPURA	60,740	295	4.43
	POLONNARUWA	60,647	401	13.03
Eastern Province	TRINCOMALEE	21,152	51	2.02
	BATTICALOA	23,811	180	6.90
	AMPARA	33,716	115	2.72
Southern Province	GALLE	31,981	23	1.42
	MATARA	29,890	19	1.50
	HAMBANTOTA	47,753	155	6.21
SABARAGAMUWAI Province	KEGALLA	10,663	13	0.77
	RATNAPURA	119,015	279	8.62
UVA Province	BADULIA	17,173	83	2.94
	MONARAGALA	30,679	286	5.19
TOTAL		1,384,413	3,304	5.82

❍ The data model of the LIS DB consists of the Geo-Database defined by the Survey Department of Sri Lanka, the definition of files and folders in data management, the definition of GeoDB, the definition of Feature Database, the definition of GeoDB Feature Class and Table, and the definition of Field for Feature Classes.

❍ Folder names for data management are separated by DD. Each folder contains GeoDB folders and the local administrative boundaries, village unit boundaries, and cadastral block boundaries.

❍ GeoDB, which comprises the writing information, is managed by dividing the records into "Live" and "Deed" in the Feature Dataset, and each of the fields in the form of polygon contains the property information such as serial number, legal basis, land name, land use, claiman, etc.



[Figure Ⅲ-2] Definition of LIS Geo-Database

❍ Data model of LIS currently in operation is configured to accommodate GeoDB, which is the computerized information of the existing Survey Plans, and has a unique ID that can be linked to the Survey Plan's attribute information. It is necessary to define data model that can extend attribure information.

1.3. Spatial Information Analysis for Major MCs

❍ Currently, 1:50,000 and 1:10,000 digital topographical databases distributed by the SDSL can be utilized, but there is considerable omission of information to be used as basic data for land, construction and tax-related work of local governments.

❍ Although 1:1000 scale topographic DB can be used for some Colombo districts, this is also limited to the use of administrative work by local governments due to the omission of attribute information.

❍ Although the demand for land information for various administrative activities by local governments is rapidly increasing, the information on the numeric cadaster (LIS DB) is limited to areas where the Bim Saviya Programme applies, thus the sharing of land information and efficient utilization of land information is not carried out.

❍ In areas where the Bim Saviya Programme has not yet been implemented, private surveyors entrusted directly by the applicant for land movement (registration, division, annexation, etc.) utilize the old Survey Plan to carry out surveys on the land, and thus obtain a permit for land movement from the local government by confirming the land survey performance.

❍ In cadaster areas, where the Bim Saviya Programme has not yet been implemented, the results are checked by district survey office, but in the sporadic areas, the local government’s Planning Division performs on-site verification.

❍ Even if the survey plans updated by private surveyors are inspected by the district survey offices, the management system such as serial numbers managed by the numeric cadaster are different from each other, and there is no inter-agency data sharing is being restricted because the management system is a local administrative body.

❍ Therefore, if there is basic information of all lands, this ensures that the land survey performance confirmation processes are continuously updated can be systematically managed and data sharing between relevant agencies can be smoothly carried out.

❍ Moreover, if building and street information contained in the land are provided together, information updated through administrative work of municipal council can be shared among related agencies, which can result in a more efficient information sharing system.

❍ Hence, 24 major municipal councils were selected to define a methodology for effectively establishing spatial information on key municipal council where land movement occurs frequently and to select the volume of projects targeted.

❍ 24 major municipal councils are located in areas where land administration and various licensing administrations frequently occur were selected through consultation with the Survey Department of Sri Lank, the area by district is as follows:

[Table Ⅲ-4] 24 Major Municipal Council Selection Results

District	Municipal Council	Extents(㎢)
COLOMBO	Colombo Municipal Council	40.33
	Dehiwala-Mount Municipal Council	21.07
	Kaduwela Municipal Council	88.11
	Moratuwa Municipal Council	19.26

District	Municipal Council	Extents(㎢)
	Sri Jayawardanapura Kotte Municipal Council	16.47
Gampaha	Gampaha Municipal Council	27.81
	Negombo Municipal Council	28.53
Kurunegala	Kurunegala Municipal Council	11.80
Jaffna	Jaffna Municipal Council	19.49
Kandy	Kandy Municipal Council	27.01
Matale	Dambulla Municipal Council	57.05
	Matale Municipal Council	12.16
Nuwaraeliya	Nuwaraeliya Municipal Council	13.55
Anuradapura	Anuradapura Municipal Council	46.99
Polonnaruwa	Polonnaruwa Municipal Council	38.14
Baticaloa	Baticaloa Municipal Council	38.10
Ampara	Akkaraipattu Municipal Council	5.39
	Kalmunai Municipal Council	28.53
Galle	Galle Municipal Council	18.70
Matara	Matara Municipal Council	21.02
Hambantota	Hambantota Municipal Council	82.78
Rathapura	Rathapura Municipal Council	26.37
Badulla	Badulla Municipal Council	10.61
	Bandarawela Municipal Council	8.75
Total		708.02

❍ Of the 24 major municipal councils, some MCs have established spatial information on buildings and streets to carry out their own administrative work, but the management bodies of buildings and streets have been separated and not managed collectively.

❍ In addition to the buildings and streets that are managed by the Road Development Authority (RDA) and Urban Development Authority (UDA), there is no inter-agency data sharing and integration.

❍ The target project number for parcels, buildings and streets extension by 24 major municipal councils has been extracted through satellite images and is as follows:

[Table Ⅲ-5] Number of Land Lots, Buildings, and Street Extension in 24 Major MCs

Municipal Council	No of Parcels	No of Buildings	Road Extension(km)
Colombo Municipal Council	133,138	55,474	504
Dehiwala-Mount Municipal Council	72,455	28,982	263
Kaduwela Municipal Council	254,512	121,196	1,101
Moratuwa Municipal Council	52,985	26,492	241
Sri Jayawardanapura Kotte Municipal Council	43,044	22,655	206
Gampaha Municipal Council	68,855	38,253	347
Negombo Municipal Council	82,411	39,243	356
Kurunegala Municipal Council	29,216	16,231	147
Jaffna Municipal Council	42,894	26,809	243
Kandy Municipal Council	81,735	37,152	337
Dambulla Municipal Council	164,793	78,473	713
Matale Municipal Council	28,435	16,726	152
Nuwaraeliya Municipal Council	35,412	18,638	169
Anuradapura Municipal Council	103,416	64,635	587
Polonnaruwa Municipal Council	125,909	52,462	476
Baticaloa Municipal Council	104,814	52,407	476
Akkaraipattu Municipal Council	19,276	7,414	67
Kalmunai Municipal Council	74,562	39,243	356
Galle Municipal Council	64,305	25,722	234
Matara Municipal Council	66,500	28,913	263
Hambantota Municipal Council	296,048	113,865	1,034
Rathapura Municipal Council	94,308	36,272	329
Badulla Municipal Council	30,648	14,594	133
Bandarawela Municipal Council	22,868	12,036	109
Total	2,092,537	973,887	8,845

❍ Colombo Municipal Council (CMC)

- Spatial DB for buildings and streets for 16 Wards out of 47 Wards of CMC.
- The spatial DB background map is edited and produced based on Survey Plans.
- Stationed streets and buildings in polygons on the editing background of Survey Plans.

❍ Kaduwela Municipal Council

- Currently, collection of information on streets and buildings is being conducted, and no numerical work is being done on them
- As of land lot, data is being compiled based on Survey Plans

❍ Galle Municipal Council

- Built spatial data for buildings and streets on separately.
- About 300 spatial data of buildings and streets are being updated per year.
- As of land lot, data is being compiled based on Survey Plans

❍ Kandy Municipal Council

- Data on buildings and streets are collected and stored in a document format by the management institution.
- As of land lot, data is being compiled based on Survey Plans

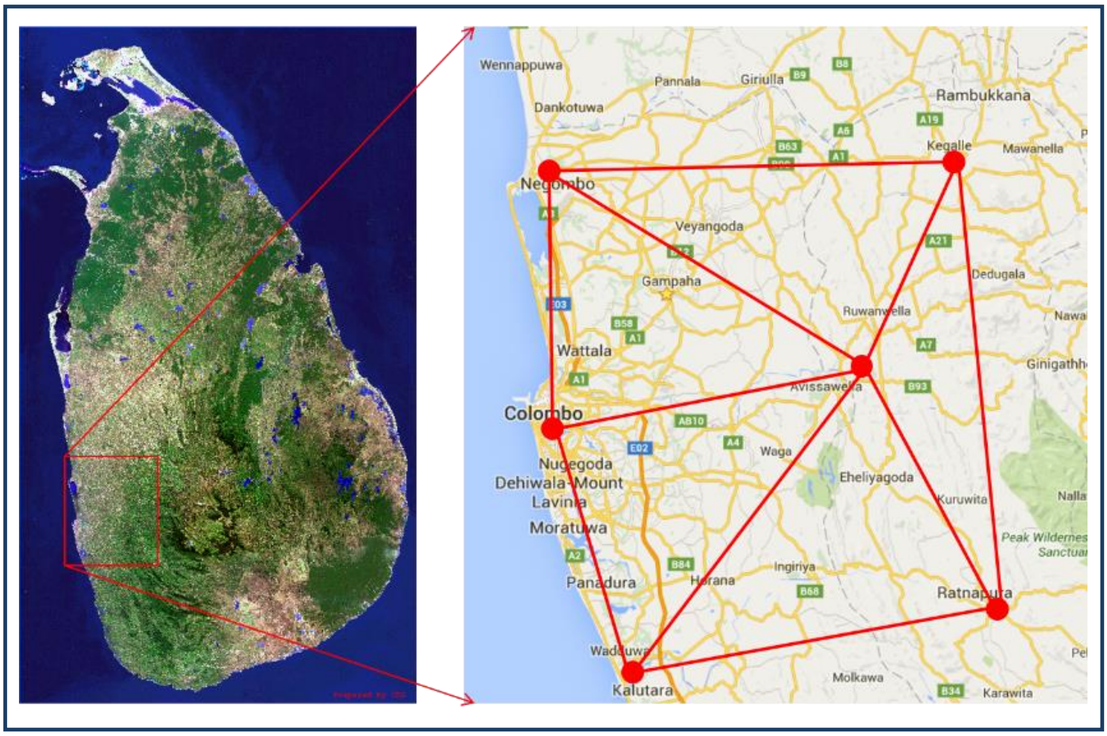
❍ Hambantota Municipal Council

- Most of the buildings and streets data are received and managed by the UDA and managed by the Excel format
- As of land lot, data is being compiled based on Survey Plans

1.4.CORS-Network Analysis

❍ Sri Lanka established a total of 48 SLCORSnet installation plans in 2014 and carried out six GNSS regular observatories in the Western Province as a first step. Afterwards, it has established 42 additional Continuous Observation Reference Station(CORS) through the Phase 2 and 3.

❍ The installation location of the CORS in Western Province, where SLCORSnet installation is completed, is located within the Survey Department of Sri Lanka, District Survey Office and public office for the management of CORS in Colombo, Kalutara, Ratnapura, Avissawella, Kegalle, and Katana



[Figure Ⅲ-3] SLCORSnet Installation Location (Phase 1)

❍ Each CORS has a circular concrete column installed on a concrete base with a depth of 1m, a regular platform attached to the top, and a choke ring GNSS antenna from Topocon is installed on a horizontal platform.

❍ The concrete column is equipped with a weather sensor and a lightning rod is installed to protect the GNSS antenna from lightning hazards.

❍ The internal panel connected to the GNSS antenna is connected to a T-G5 GNSS receiver from Topcon. Solar panels, solar charging controllers, and solar backup batteries are installed in case of power failure, such as power failure.

❍ In addition, a router is installed to send real-time GNSS raw data to the Control Center, and a network connection is made to the SLT (Sri Lanka Telecom).

Colombo (Survey General's Office)

Kalutara (District Survey Office)

Ratnapura (Metrological Office)

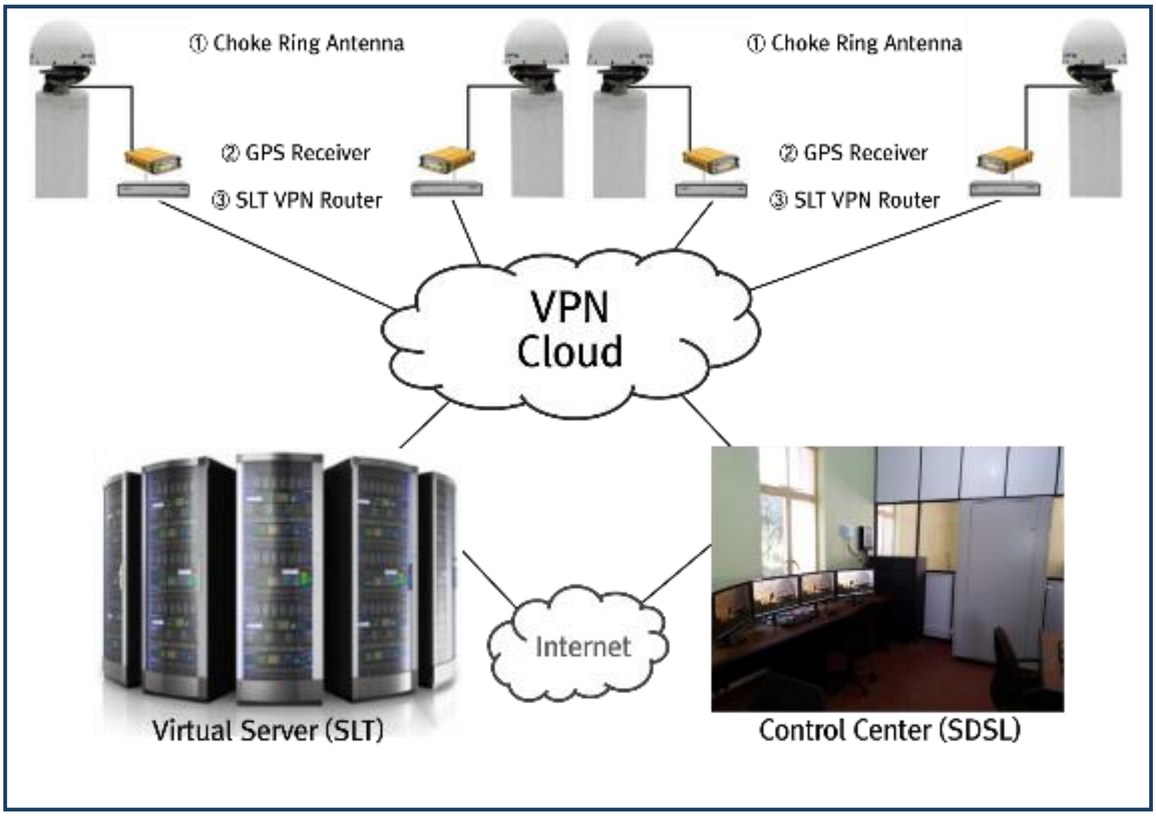
Avissawella (RDA Office)

Kegalle (District Survey Office)

Katana (National Police Academy)

[Figure Ⅲ-4] CORS Installation Status

❍ Control center for 6 CORS of Phase 1 is installed within the Survey Department of Sri Lanka and real-time GNSS raw data from each CORS is sent through the Sri Lanka Telecom (SLT) network to the Control Center server and the virtualization server of SLT, and data security is maintained through SLT's VPN Cloud.

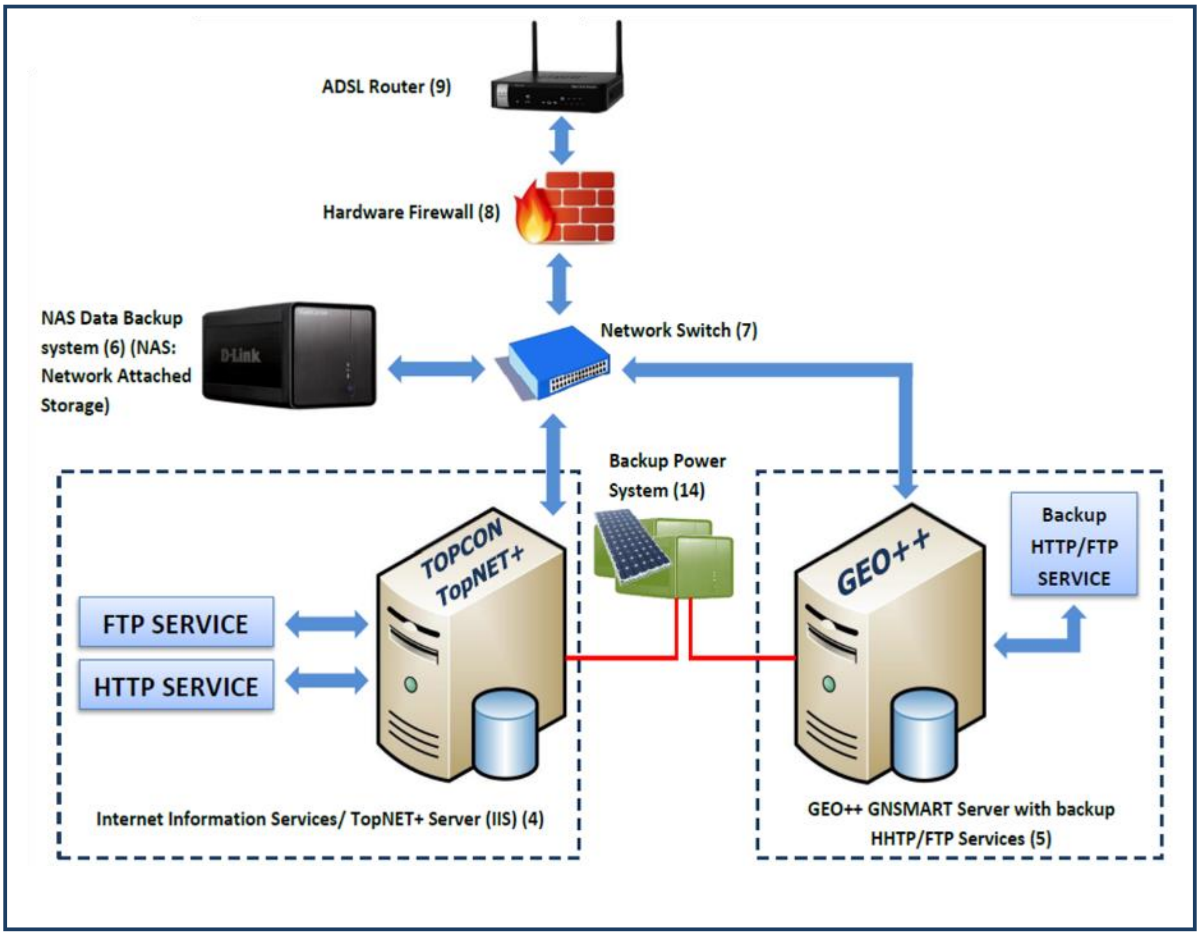


[Figure Ⅲ-5] GNSS Raw Data Transfer System

❍ Control Center utilizes Geo++ GNSMART solution from Germany to perform real-time, post-processing and RINEX online services, each of which is serviced via the SLCORSnet web page.

❍ Sri Lanka's SLCORSnet Phases 2 and 3 are planned to be installed a total of 42 additional installations in order to maintain the 50 to 60 km of each CORS, but this is proposed by Trimble Corporation for the purpose of Network RTK (VRS[36], etc.) for use in Single Baseline Real Time Kinematic Survey, which maintains a distance between mobile and reference countries within 30 km.

36 VRS(Virtual Reference Station) is a network RTK GNSS survey method that uses a reference station network composed of GNSS stations to determine the precise position through real-time kinematic survey between virtual reference points and rover point



[Figure Ⅲ-6] Control Center H/W and S/W Diagram

❍ When Single Baseline Real-Time Kinematic Survey is serviced, utilization of Single Baseline Real-Time Kinematic Survey is greatly reduced, and most of the kinematic surveys are carried out in real time by VRS.

❍ Therefore, it is necessary to re-establish the plan for installing additional CORS with priority VRS services throughout Sri Lanka and to make a feasibility analysis of the plan.

❍ The VRS service, which is used as a multiple GNSS reference network, is maintained even if the baseline distance is extended to 50km, compared to the single baseline kinematic survey method, which maintains accuracy within 30km. Therefore, additional CORS is installed for the nationwide based on 100km between GPS stations. It is reasonable to re-establish the plan.

❍ When considering VRS services for some southern and northern island areas of Sri Lanka, CORS cannot be installed in the outer areas of the islands, so more compact CORS deployments than inland areas should be considered.

1.5. Availability Analysis of Satellite Image

❍ Sri Lanka used a variety of satellite images to update the 1:50,000 digital map and the 1:10,000 digital map was updated using Digital Global Corporation's Quickbird image in 2008 and 2009.

❍ The Geo Informatics sectio of the SDSL is attempting a technical approach to use satellite imagery in addition to aerial imagery, but it is currently experiencing difficulties in supplying high resolution satellite imagery, and only partially receiving satellite imagery through aid projects. There is on image map production for nationwide of Sri Lanka.

❍ Geo Informatics' Remote Sensing Branch uses multi-purpose satellite images to modify/renew 1:50,000 digital map and produces Land Cover Map for nationwide using Landsat 8 satellite images.

❍ Currently, 50cm high-resolution satellite images are widely available worldwide, and commercial satellite images such as Digital Global Corporation's GeoEye-1, WorldView-2, WorldView-3, and Airbus' Pleiades-1A and Fleiades-1B are widely available, but the Sri Lankan government is not receiving them directly due to budget problems.

❍ Demand for high-resolution satellite images such as SLSDI (Sri Lanka Spatial Data Infrastructure) projects and Survey Department of Sri Lanka work is increasing, but support is very poor.

❍ Therefore, if high-resolution satellite images are distributed throughout Sri Lanka and 50cm satellite images are produced, this image can be used as basic information for the sharing of data related to land-related activities and related agencies, including the constant renewal of the map.

❍ The Sri Lankan government is requesting the provision of high-resolution satellite images through the EDCF project in Korea, and the computerization of the existing Survey Plans is required using the high-resolution satellite imaging provided.

❍ As Korea's multipurpose satellite 3/3A is a Korean technology-developed satellite that can provide commercial-grade images of up to 50cm, it is necessary to provide high-resolution satellite images throughout Sri Lanka and analyze the feasibility of producing 50cm satellite images.

❍ In addition, economic feasibility should be analyzed by defining a methodology that can improve the DB construction process required by this project through the provision of 50cm satellite images, and the value of using the country for high-resolution satellite images should be analyzed together.

1.6. Requirement Analysis

❍ Sri Lanka produces and manages the numeric cadaster through the Bim Saviya Programme, but the progress is very poor and it is trying to establish land status information for all of Sri Lanka in the graphic cadaster format.

❍ Accordingly, it was intended to manufacture the primary graphic cadaster through computerization of Survey Plans managed by the district survey office under Survey Department of Sri Lanka.

❍ Geo-referencing and digitizing of existing Survey Plans was performed on its own, but the progress was very poor due to the accuracy of the base map and the time and cost of direct survey.

❍ Therefore, it is required to establish a methodology that utilizes high-resolution satellite orthoimage as the base map for geo-referencing and to provide high-resolution satellite orthoimage.

❍ Based on 5cm grade-level aerial orthoimage, 24 major municipal councils will establish proactive spatial DBs for parcels, buildings and streets to share geospatial information between the SDSL and municipal council.

❍ The shared land information is updated through administrative work of each relevant institution, and the updated process involves direct survey, which can speed up the construction of the numeric cadaster.

❍ In order to make more general use of GPS survey in conducting general survey activities, such as updating land information, the government plans to establish a network RTK service for nationwide.

❍ This requires additional installation of CORS-Network to expand Network RTK throughout the nationwide of Sri Lanka, which is being serviced as Phase 1 by Western Province.

❍ Therefore, the feasibility of creating 50cm high-resolution satellite orthoimage and installing additional CORS-Network for nationwide was analyzed, and a DB construction methodology using them should be defined.

2. Analysis of Land Data Model

2.1. Data Model Overview

❍ A data model is a conceptual model that simplifies and abstracts information in the real world to be presented in a computer, and is systematically tabulated as a conceptual model for describing data, its relationship, its meaning and consistency, and constraints.

❍ The SDSL manages numeric land parcel surveyed by identical national grid coordinate, and the surveyed data in the area of the Bim Saviya Program is named as cadastral data and the other area is named sporadic data and managed as a separate schema

❍ Meanwhile, Sri Lanka completed the project "Building a Table Reference Model and Creating a Continuous Geographic Map for Modernizing Land Information in Sri Lanka" in January 2018, and presented suggestions and improvements to the following land data models in the pilot project.

[Table Ⅲ-6] Implications and Revisions Through Pilot Project

Implication	Improvement
Although the LIS data model in Sri Lanka is defined, it is not considering service and application as a model for managing land information data.	A new data model in Sri Lanka should be defined by the comparison/analysis of the current LIS Data Model and the application service functions of the stakeholders
Building a new data model that conforms to international LADM definitions and considers Sri Lanka's reality-conforming application is urgent	Unit identifiers for each of the fields currently in use are unit identifiers for linking them to attribute information in various service sectors, so new unit identifier definitions are required.

[Table Ⅲ-7] Cadastral Schema

Field Name	Definition	Geometry	Note
PCL_PG	Cadastral Parcel Polygon is parcel by cadastral survey	Polygon	Nodes and parcel succession coordinate system
PCL_IF	Parcel information related to cadastral parcel	-	Referenced from TL of plan
SHT_PG	External boundary for individual cadastral survey work	Polygon	Reference from all external boundaries of the combination of parcel number (Lots)
SHT_IF	Sheet information related to cadastral sheet	-	Referenced from TL of plan
PCL_LN	Boundary division and open circuit between two nodes	Arc	Automatic generation from layers of surveyed boundaries
PCL_ND	This point (node) is created at each end point of the other layer	Node	Automatic generation from layers of surveyed boundaries

[Table Ⅲ-8] Sporadic Schema

Field	Definition	Geometry	Remarks
SPCL_PG	Sporadic Parcel Polygon is parcel by sporadic survey	Polygon	Nodes and parcel succession coordinate system

Field	Definition	Geometry	Remarks
SPCL_IF	Parcel information related to sporadic parcel	-	Referenced from TL of plan
SSHT_PG	External boundary for individual sporadic survey work	Polygon	Reference from all external boundaries of the combination of land lot number (Lots)
SSHT_IF	Sheet information related to sporadic sheet	-	Referenced from TL of plan

2.2. Data Model Definition

❍ Sri Lanka defined a LIS-based data model for the adequate utilization of land information, which is defined based on the cadastral data.

❍ Currently, LIS DB defined based on Cadastral Data is defined as Parcel_Polygon, Parcel_Info, CM_Polygon, Sheet_Polygon, Sheet_Info, Parcel Boundary, Parcel Node, and Administrative Boundaries.

❍ Parcel_Polygon represents closed a parcel and one of the most basic unit structures that make up the LIS DB.

[Table Ⅲ-9] Definition of Parcel_Polygon

		Attribute	Short Name
Definition	The Land Parcel is the basic feature in LIS defined with an identical number, which consists an Extent and a definite boundary.	Parcel ID Sheet Number Parcel Type Parcel Status Status Date Lineage	PCL_PG_ID SHT_PG_ID PCL_PG_TP PCL_PG_ST PCL_PG_DT PCL_PG_LG
Table Name Geometry Capture	PCL_PG Polygon Coordinates of the Nodes & Parcel Inheritance	Entity Reliability Action Suspend Extent Shape Old Plan Reference	PCL_PG_ER PCL_PG_AS PCL_PG_ES PCL_PG_OR

❍ Parcel_Info includes information about a field formed by a closed parcel, including its identity and area, land use, and owner information.

[Table Ⅲ-10] Definition of Parcel_Info

		Attribute	Short Name
Definition	The Table; Parcel History list out all the dead Parcel numbers, which are removed from the table; PCL_PG having updated for subsequent surveys.	Parcel Info ID Parcel ID Extent Legal Name of Land Land Use	PCL_IF_ID PCL_PG_ID PCL_IF_EL PCL_IF_LN PCL_IF_LU
Table Name	PCL_IF	Claimant Name	PCL_IF_CN

Geometry Capture	None TLDb Upload	Remarks	PCL_IF_RM

❍ CM_Polygon is an index for the Cadastral Map, which table the index of an cadastral drawing con sisting of minimum administrative boundary (GN) or village (Village) units, and includes CAD dr awing numbers, CAD drawing forms, and CM (GN/Village) names.

[Table Ⅲ-11] Definition of CM_Polygon

Definition	Cadastral Index is the map showing the selected areas for initiating each field survey task. This area will be subdivided in to block/zones to conduct surveys for producing of CM map sheets. CM Boundary (GN/Village based) should be sketched and 6-digits identical number be issued for each CM polygon. Boundaries should be adjusted at block merge stage after completion of the relevant block surveys.	Attribute	Short Name
		CM Index Location Index CM Name CM Type	CMI_PG_ID ADM_GN_IX CMI_PG_NM CMI_PG_TP
Table Name Geometry Capture	CMI_PG Polygon Sketch & Adjustment		

❍ Sheet_Polygon is a block of continuous parcels that represents the unit of cadastral drawing printed for field survey work and includes the block number, location within CM_Polygon, and Sheet Index.

[Table Ⅲ-12] Definition of Sheet_Polygon

Definition	Cadastral map Sheet is the official printed document for each field survey task. The Sheet-1 is prepared at the first stage of the survey to show the Block (Zone), the basic unit assigned for survey and preparation of Cadastral Map. block Boundary should be sketched and 8-digits identical number be issued for each block. Boundaries should be adjusted at parcel level accuracy after completion of the initial survey.	Attribute	Short Name
		Sheet Index Block Number Location Index Sheet Status	SHT_PG_ID SHT_PG_BN ADM_GN_IX SHT_PG_TP

Table Name Geometry Capture	SHT_PG Polygon Sketch & Adjustment		

❍ Sheet_Info consists of attribute information for Sheet_Polygon and contains records of the year and field note number, survey technician, and survey progress procedures, etc.

[Table Ⅲ-13] Definition of Sheet_Info

		Attribute	Short Name
Definition	Sheet_Info field attributes are subjected to collect from the TLDb-CM Sheet	Sheet Number Field Book No. SG Req No Surveyor Year Survey Checked by Certified by Date Completd Bound Swby Bound Swto	SHT_PG_ID SHT_IF_FB SHT_IF_RQ SHT_IF_SY SHT_IF_YS SHT_IF_CH SHT_IF_CT SHT_IF_DC SHT_IF_SB SHT_IF_ST
Table Name Geometry Capture	SHT_IF None Link/Trace from TLDb		

❍ Parcel Boundary refers to the boundary line of land lot created from the DXF layer in the CAD file and includes the Parcel Bound ID, Bound Status, etc.

[Table Ⅲ-14] Definition of Parcel Boundary

		Attribute	Short Name
Definition	Polyline. Boundary Segments between 2-Nodes. Nodes are created at each end vertices of Boundary segment in different layer. Automated process.	DSR Index ID Parcel Bound ID Bound Status Status Date Date Completd Bound Swby Bound Swto	DSR_IX_ID PCL_LN_ID PCL_LN_ST PCL_LN_DT SHT_IF_DC SHT_IF_SB SHT_IF_ST
Table Name Geometry Capture	PCL_LN Arc Auto generated from field data layers of surveyed boundaries		

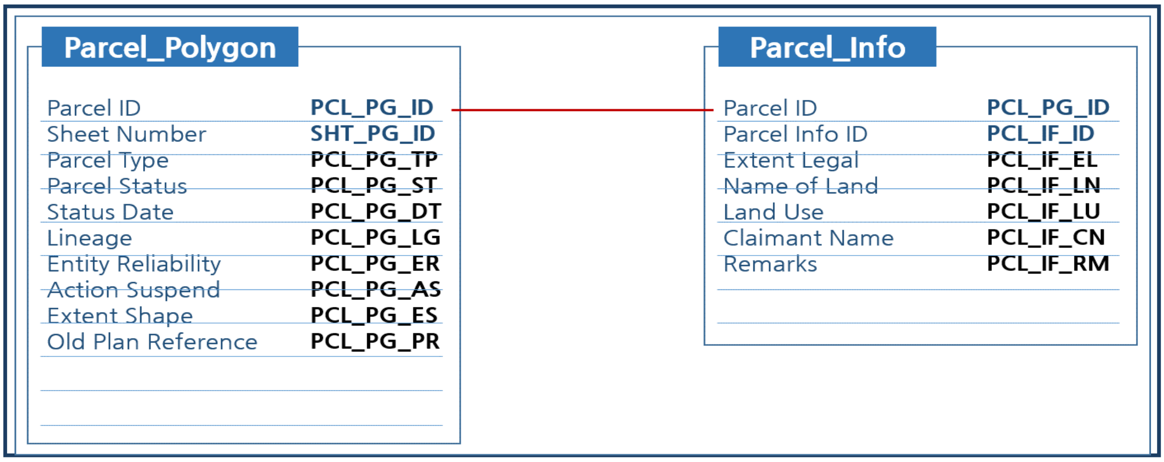
❍ Parcel Node consists of a node that forms a single Parcel and contains the table on the left of each point.

[Table Ⅲ-15] Definition of Parcel Node

<table>
<tr><td rowspan="2">Definition</td><td rowspan="2">These Point (Nodes) are created at each end vertices of line segment in different layer. All the other vertices of lines between said nodes are ignored and create the polyline.</td><td>Attribute</td><td>Short Name</td></tr>
<tr><td rowspan="2">DSR Index ID
Node ID
North Cood
East Cood
Elevation
Node Status
Status date</td><td rowspan="2">DSR_IX_ID
PCL_ND_ID
PCL_ND_NC
PCL_ND_EC
PCL_ND_ZC
PCL_ND_ST
PCL_ND_DT</td></tr>
<tr><td>Table Name
Geometry
Capture</td><td>PCL_ND
Node
Auto generated from field data layers of surveyed boundaries</td></tr>
</table>

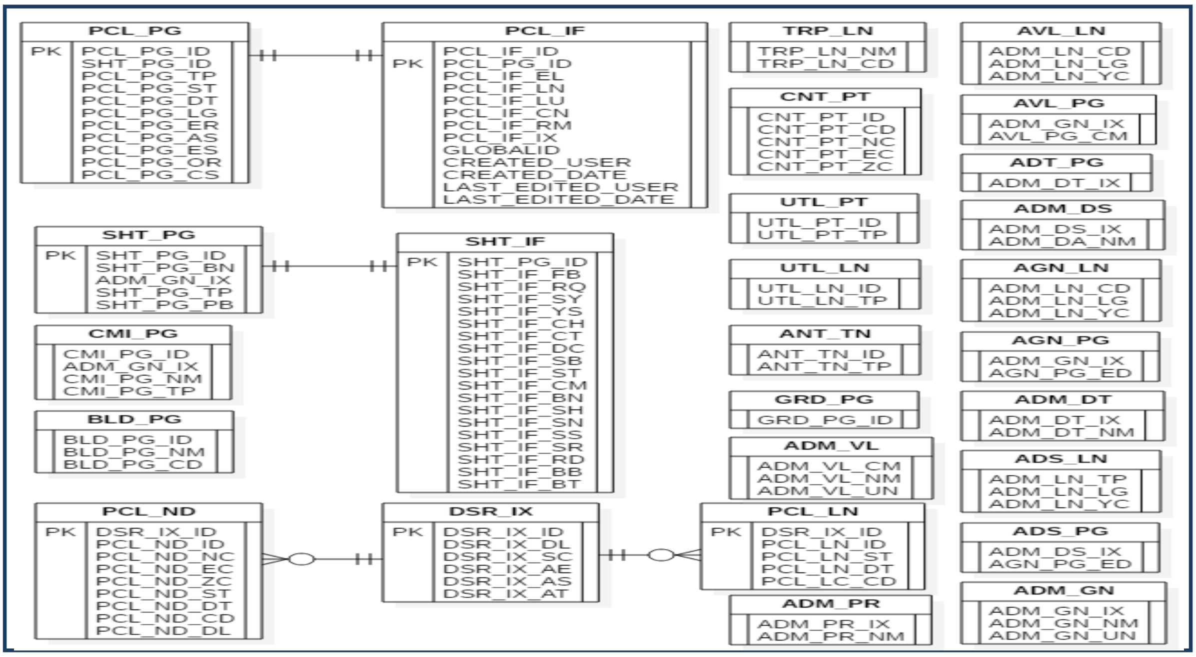
2.3.Data Model Structure

❍ Each defined data model has an interconnected structure through a unit identifier, and Parcel_PG_ID and Parcel_Info are configured to refer to each other's data.



[Figure Ⅲ-7] Reference Relations of Land Lot Spatial Data and Attribute Data

❍ Sheet_Polygon and sheet_Info refer to the data using the sheet Polygon ID (SHT_PG_ID) as identifiers and the relationship diagram of the LIS data model is as follows:



[Figure Ⅲ-8] ERD for LIS Data Model

2.4. Implications

❍ Land data in Sri Lanka is generated from Cadastral Data and Sporadic Data, but the current LIS data model is configured to link Sporadic Data.

❍ Parcel ID, a major identifier for the LIS data model, lacks connectivity with Sri Lanka's address system, which does not include any capability to connect roads and buildings.

❍ Therefore, the automatic conversion system of existing Parcel IDs should be established along with the redefinition of Parcel IDs through unit identifiers that can be linked to Sri Lanka's road name-based address system.

❍ The current LIS data model contains data on the administrative work of generating land data, but does not include data on the practical level to utilize the data, so re-establishment of the data model through analysis of land administration work must proceed.

❍ The current LIS data model consists of a package containing spatial components related to the acquisition of land data, but the package for the physical spatial components for the connection of the land data to the road or building is insufficient.

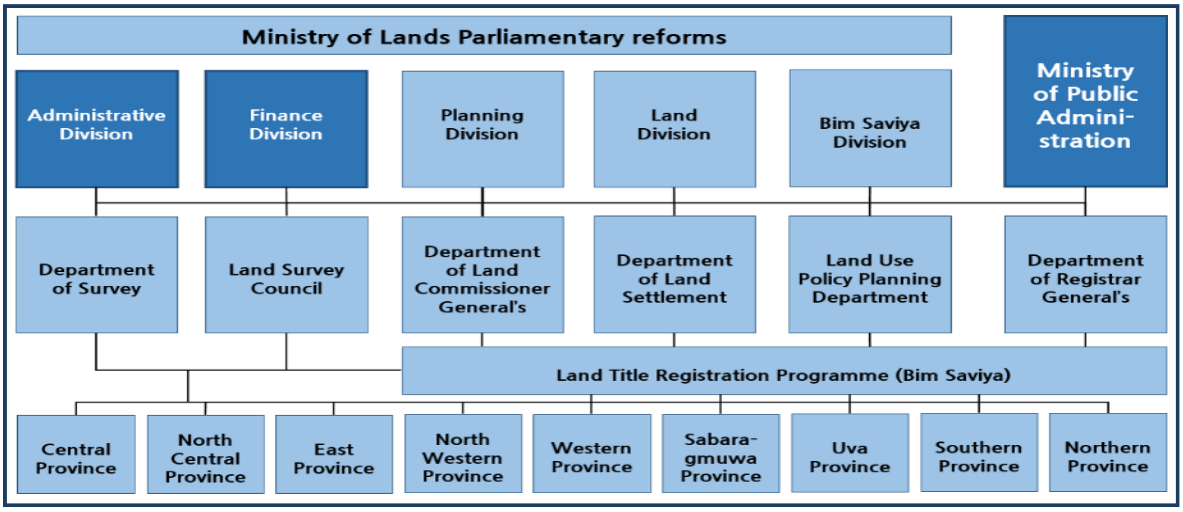
❍ In addition, there is no defined package of processes for performing land administration through land information, so the packages for ownership, regulation and responsibility, administrative organization, etc. must be defined and new data models integrated with them must be re-established.

3. Land-Related Work Analysis

3.1. Land-Related Work Overview

❍ Land-related work in Sri Lanka is centered on the Ministry of Lands and Parliamentary Reforms (MoLPR), which consists of five divisions, six offices, and each local subsidiary organization for general administration, financial work and land-related work.

❍ Land-related work of the Land Ministry is divided into the land planning sector, the land management sector, the land development sector and the land conservation sector, and the land planning department is responsible for the work on laws, systems and ordinances, land policy and land use planning.



[Figure Ⅲ-9] Land-Related Organization

❍ The Land Management Division is in charge of cadastral survey, cadastral computerization, establishment and linkage of national spatial information, land registration-related survey and land information system, while the Land Development Division is in charge of land acquisition and transfer and adjustment of land disputes.

❍ In addition, the Land Conservation Department is in charge of resource protection, resource management and conservation, and each institution has the following types of land-related work:

[Table Ⅲ-16] Categorization of Work Types Per Land-Related Organizations

Land-Related Organization	Pending Issue of Major Work	Land-Related Work Type			
		Plan	Management	Development	Conservation
Survey Department	Cadastral survey		○	○	
	Cadastral Map Management and Cadaster Computerization	○	○		
	Land information system (LIS)	○	○	○	○

Land-Related Organization	Pending Issue of Major Work	Land-Related Work Type			
		Plan	Management	Development	Conservation
	National spatial information construction and connection	○	○	○	○
	Land registration-related survey work		○		
Land Survey Council	Standardization		○		
	Survey regulation and procedure certification	○	○	○	
Land Commissioner General's Department	Transferring national land	○	○	○	
	Long term lease of national land	○	○	○	
	National land management	○	○	○	○
	National land development		○	○	
	Resource conservation and protection		○		○
Land Settlement Department	Dispute land management	○	○		
	Dispute land control and resolution		○		
	Dispute-solved land's ownership specification / registration		○		
	Bim Saviya Programme		○		
Land Use Policy Planning Department	Land use policy		○	○	○
	Land use plan	○	○	○	○
Register General's Department	Land registration and certificate issuance		○		
	Land transaction management		○		
	Land history management		○		

3.2. Land Registration Work

❍ The land registration procedure in Sri Lanka is divided into the Bim Saviya Programme area, which is a national Land Title Certificate issuance system, and other area.

❍ The target location of the Bim Saviya Programme is designated by the Land Ministry of Lands and Parliamentary Reforms (MoLPR), and the target location information is notified to the Land Settlement Department and the Survey Department of Sri Lanka.

❍ Land Settlement Department checks all the deed information in the designated area, declares it as a TR area under paragraph 1 of the TR Act, adds it to the Gazette, visits the land owner, and asks for the land owner's consent.

❍ Land Settlement Department sends a list of land owner in a designated area to the Survey Department of Sri Lanka's competent District Survey Office for survey.

❍ The District Survey Office assigns the field survey work to the responsible Divisional Survey Office, and the surveyor of divisional survey office at the local survey site, along with the person in charge of the land settlement office, examines the parcel information (parcel number, owner information, dead information, Old Plan and Asset No., etc.).

❍ In addition, surveyors perform a total station or GPS Survey on the site based on Old Plan and reference point information, and upload the survey results to SRIMS(Survey Requirement Information Management System).

❍ Based on the results of the land survey, the landowner personally visits the district office of the Land Settlement Department to apply for the issuance of the land certificate, and the district office of Land Settlement Department conducts on the basis of the documents received, and sends the results of the field survey to the main office for approval.

❍ If the results of an on-site survey upon application for issuance of a land certificate are approved, the results must be published in the government official gazette and, if there is no objection, the land certificate must be issued.

❍ If objections are raised in accordance with the issuance of a land certificate for the land concerned, the registration procedure must be suspended and the case of objection must be sent to the competent court.

❍ Areas not designated as the Bim Saviya Programme area are divided into the Cadaster and Sporadic areas, and land registration in those areas is handled by local authorities in the form of a deed by Survey Plans.

❍ In the case of the Cadaster district, a person who wishes to apply for land registration directly requests a surveyor who receives the required land information and receives the Old Survey Plan of the corresponding field from the competent district office under the Survey Department of Sri Lanka to prepare for the survey of the field and proceeds directly to the required land survey on the basis of the survey.

❍ The authorized surveyor submits the newly surveyed Survey Plans to LA/MCs in the form of paper drawing and computerized file.

❍ In the Sporadic district, the applicant who wishes to apply for land registration directly requests a surveyor who receives the required land survey results and the required land information from the competent district survey office under the SDSL to prepare for the survey of the land.

❍ In the Sporadic area, the land registration process is carried out by Land commissioner general or Divisional Secretary, and a licensed private surveyor conducts the direct survey of the parcel boundary.

❍ For private lands in the Sporadic area, an authorized surveyor will prepare a Survey Plans with buildings, adjacent roads, and water supply lines, etc. in the parce.

❍ The applicant submits Survey Plans (represented by buildings on parcel, adjacent roads, and water supply & drainage lines, etc.) from the authorized survey engineer to apply for registration of the document to the municipal council's planning division. If there is no problem, the planning committee will approve the application.

3.3. Land sub-Division and Amalgamation Work

❍ Sri Lanka has land division and land annexation for land-mobilization work, which are mostly focused on land-division activities.

❍ Municipal councils are in charge of land movement for private land, and state-owned land is directly in charge of state land.

❍ In the case of state land division, when the Divisional Security submits a survey to the Survey Requisition Information Management System (SRIMS), the Survey Department of Sri Lanka sub-subsidiary will assign surveyors to the site, and the designated surveyor will perform direct survey and upload survey results on the site.

❍ District Survey Office checks uploaded Survey Plans and sends them to the Division Secretaries for completion.

❍ Land division or annexation is handled by the Municipal Council or Land Authorit.

❍ In the case of land division in the Cadaster district, land division approval is obtained by directly submitting the newly surveyed Survey Plans to the MC/LA in the same way as the land registration procedur.

❍ Land division in Sporadic district was carried out according to the same procedure as land registration in Sporadic district. Also, the applicant who wishes to apply for land division was asked to survey land division to a survey engineer who was authorized to apply for land division.

❍ The land division in the sporadic district is made by a licensed private surveyor submitting the Survey Plans (buildings in the parcel, adjacent roads and water and sewage lines, etc.) to the municipal councils for approva.

❍ After receiving the necessary information from the District Survey Office, the authorized survey technician submitted Survey Plans (such as buildings within land, adjacent roads and water supply lines, etc.) to the municipal council, and approved the final land division through on-site inspection by the municipal council.

❍ The minimum standards for land division stipulated by municipal councils are mostly in accordance with the provisions of the Urban Development Authority, as follows:

- As of flat land (Slope 0°~ 10°), minimum division standard of land is 6 perches (Approx. 150㎡)
- As of flat land (Slope 20°~ 30°), minimum division standard of land is 30 perches (Approx. 750㎡)

– As of flat land (Slope 30°~ 40°), minimum division standard of land is 45 perches (Approx. 1,125㎡)

– Land of more than slope 45° cannot be divided

3.4.Requirement Analysis

❍ When conducting cadastral surveys in the SDSL, surveys are easy because if the target area is an existing survey area, the relevant survey documents and survey plans are referenced. However, it takes 3~4 days to search existing survey plans and prepare a survey. Therefore, it is necessary to reduce survey preparation time through computerization of existing survey plan.

❍ DoRG requests land information when issuing a Title certificate. Previously, DistSO sent a copy of the survye plan to DoLG for this purpose, but not now. As a supplementary, they access the LIS homepage of the SDSL to check and use the cadastral information. In the future, they want to go online through the new system to search for the desired land information and use it for certificate issuance

❍ DoLCG(GN, Grama Niladhari) received survey plan from the SDSL However, In case of re-grant after a certain period of time, they can't connect the survey plan and the grant land by various reason such as lost of plan or absence of an index map or lack of relevant knowledge of the officials in charge

❍ When the LSD execute Bim Saviya program, the information of the land owners of the target area is retrieved offline, and the survey plans are also received offline from the SDSL. In addition, sharing of the progress of each status is not enough, so waiting time is increasing. They request searching information related to the target site in the future system, and request that the progress of each status will be shared with all relevant organization

❍ Local governments (MC) use assessment numbers for tax purpose for land and buildings. This is different from the administrative division divided by the SDSL and is not the unique number to use reference key. They request the answer for how to connect and update this assessment number with the cadastral plan

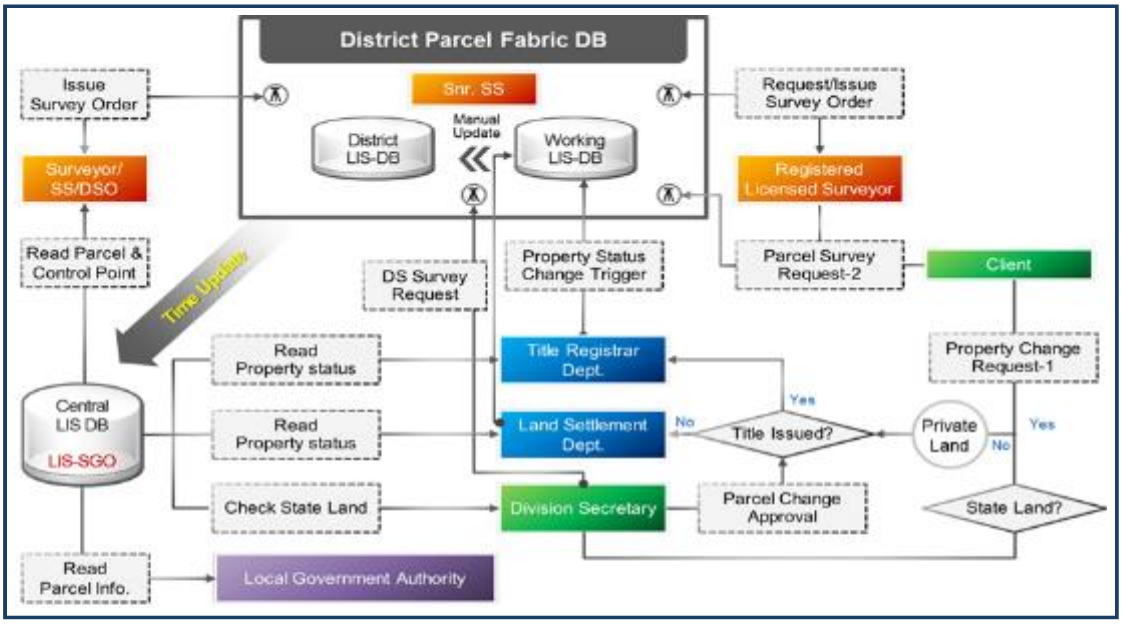
3.5. Implications

❍ Survey Department of Sri Lanka is responsible for most of the survey activities for the landowner's private land registration region (Bim Saviay Programme region) and state land, and authorized private survey engineers are in charge of the survey activities for other area.

❍ In the case of land survey-related to land registration and movement organized by the SDSL, on-line is not performed between the SDSL and the District Survey Offices, and between the district survey offices and divisional survey offices.

❍ Land survey performance is managed for SDSL, but Survey Plans submitted by authorized private survey engineers are managed in the form of drawings and computer files, but cannot be managed comprehensively because the Survey Plan's serial number is arbitrarily assigned by a private survey engineer.

❍ Survey Department of Sri Lanka related to the registration and movement of land in the Bim Saviya Programme region and state land is as follows:

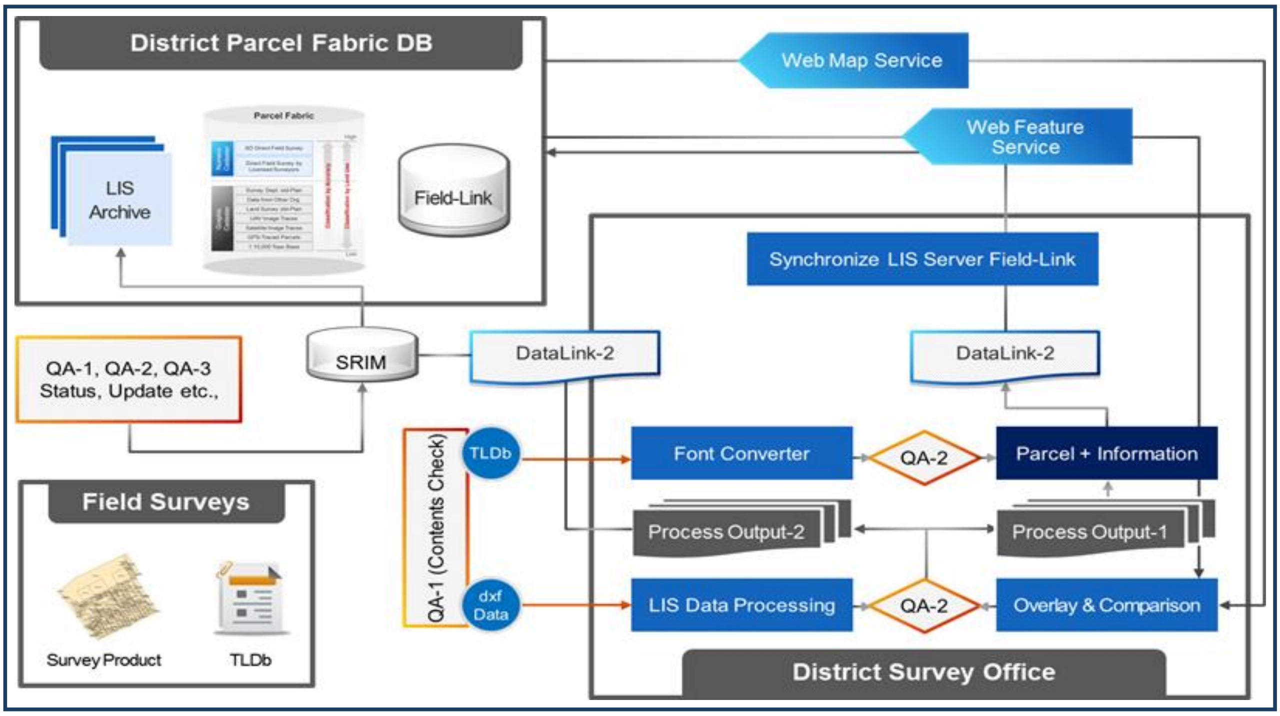


[Figure Ⅲ-10] Land-Related Survey Work Procedure

❍ Thus, the management and sharing system of land survey performance between the municipal council and the SDSL should be formed, and information updated through administrative work involving land survey by each institution should be applied and shared real-time.

❍ To this, the improvement of the system of land-related survey work and the introduction of the On-Line system of land-related survey work performed by human private surveyors, including the SDSL internal survey work, should precede the introduction of the land-related survey system.

❍ Therefore, the following structure of the land survey On-Line Working Model is required:



[Figure Ⅲ-11] Real Time Sharing Model For Survey Results

4. Land-Related Work System Analysis

4.1. Survey Department of Sri Lanka Work System

❍ A total of 14 systems are operated, including SRIMS, Survey Requisition Information Management System, which is configured for access to internal systems through the Survey Department of Sri Lanka website.

[Table Ⅲ-17] Work System Operation Status of Survey Department of Sri Lanka

No.	System Name	Definition	Established Date	Managed Department	Note
1	Pro MS	Progress Monitoring System	2014	District /divisional survey office	- Vehicle management, survey machine management; purchase year, vehicle mileage, etc. - Divisional office sends information to distributed office
2	HuRIMS	Human Resource Information Management System	2014	Officer of Survey Department	- Manage personnel information for all employees
3	SRIMS	Survey Requisition Information Management System	2014	District Office	- In case of emergency survey of national land, the authorized surveyor shall be employed for survey and access authority (upload authority) - TLDMS CONNECTED: Information retrieval of Geo-SRIMS through SRIMS

No.	System Name	Definition	Established Date	Managed Department	Note
4	Geo-SRIMS	Geometric Survey Information Management System	2014	District Office	- Procedure management from application for GCP survey to approval and termination of application
5	TLDMS	Tenement List Data Management System	2018	District Office	-
6	SMS	Stock Management System	2014	Procurement & supply branch	- Stock management system such as desk, chair, etc.
7	Inventory Perishable Store & Form	Office Supplies Management System	2016	Procurement & supply branch	- Applications for office supplies (paper clips, etc.)
8	Document Management System	Plan Information Management System	2018	Document Management Department	- Measuring agency plan and related information management system - Search by plan no.
9	Technical Library Management System	Technical Book Management System	2016	R&D Department	- Managing books held by libraries in survey offices: Entering book loans and return information
10	User Access	System Environment Management System	2002	IT Department	- Manage e-mail for all employees, agree on policies, and provide configuration information
11	Scholarship	Provision of Scholarship Information	2014	R&D Department	- Providing scholarship information for employees to apply for
12	Old TC System		2018	District Office	- Enter the TL information of the old plan to digitize the old plan and connect it to each other to service it as a 'special data infrastructure' - Connects with TLDMS DB
13	Issue LDO Diagram	Issue Land Development Ordinance diagram	2019	SDSL HQ, District survey office	- System to check how many plans are made for the land alignment - Plan for Grant certification is produced in the -land alignment (note the corresponding handwriting on the existing Survey Plan) - Connects with TLDMS DB
14	Circular DB		2014	legal branch	- Providing internal rules or related order information

4.2. Survey Department of Sri Lanka Web Service

❍ Survey Department of Sri Lanka (SDSL) provides 11 web services through its website, and it also carries out metadata services of spatial information, including the Land Information System (LIS), which enables identification of registered information through the Land Registration Program, Bim Saviya Program.

❍ In addition, the company also provides information on state land owned by each ministry, including map sales services, but limited information is provided in the case of SLCORS net where land information or usage fees are sold for a fee.

[Table Ⅲ-18] Web Service Operation Status of Survey Department of Sri Lanka

Web Service					
No.	System Name	Definition	Established Date	Subject	Note
1	Land Grant Survey Info	Connecting with SRIMS DB, DoLCG retrieves the Land Grant Survey information	2018	DoLCG	
2	LIS	Land Information System	2017	Entire nation	- Providing information produced through Bim Saviya - 1.2 Million land lot completed
3	Spatial Data Service & Meta data service	Spatial Information and Metadata Delivery Service	2015	Entire nation	- Providing spatial information metadata - Divide the entire Sri Lanka into 92 sheets (1:50,000) and divide one sheet into 25 tiles (1:10,000)
4	Investor's Guide for Reserves	Provide information on land owned by each ministry	2017	Entire nation	- Providing land boundary information owned and controlled by each ministry
5	GN Boundary Service		2017	Entire nation (Administrative Office)	- Built by GIS Branch - Show all administrative boundaries
6	SLCORS net			Applicant	- Build and manage outsourced from geodetic office
7	Map Shop	Map Sales Service	2015	Entire nation	- Topographic maps and topics are also sold; online payment is possible, but utilization is low.
8	Control Point	GCP Information Provision	2018	Entire nation	- Provides entire GCP location information for Sri Lanka
9	Land Parcel in CMC	CMC Land Lot Information Provision	2018	Entire nation (CMC)	- Create and provide digitized CMC maps based on old plan (town sheet)
10	Land	Information	2017	Entire nation	- Provides all measured regions

Web Service					
No.	System Name	Definition	Established Date	Subject	Note
	Searcher	provision service about survey district			(cadastral, sporadic) information - Survey the forest area with aerial photographs
11	Gazette Notification in Divisional Secretariat Boundaries		2019	Entire nation (Governmental office)	- Provision of public boundary information from Divisional secretariat

4.3. State Land Information and Management System(e-SLIMS)

❍ e-SLIMS project was launched at DoLCG in 2012 to improve effective local administrative procedures, and a pilot system was launched in January 2013 for 3 districts of the Western province. Major related agencies are Divisional Secretariat, Professional Land Commissioner Division, Land Commissioner General Department, Ministry of Lands and Parliament Reforms (MoLPR), and ICTA (Technical Assistance) for the following main purposes:

- Sharing the Local Land Grants Process with all relevant agencies including the Divisional Secretariat
- Provide applicants with detailed information on the process of applying for land vesting
- Provide details of the Government's land-related regulations and public announcement procedures
- Keep all records related to the Land Alienation electronic
- Always keep local information up to date

❍ The spectrum of state land management system can be distinguished into Land Grants, Land Permits, Annual Land Permits, Land Release for Departments, vesting orders, Long term leasing approval letter, long term leasing agreements, Yield tax permits, and land Kachchary.

❍ Key functions include State land alienation, monitoring of vested state land, follow-up measures to given state land, development and preservation of state land, and incidental information search, reporting, statistical data provision, online service, GPS land sketching, etc.

[Table Ⅲ-19] e-SLIMS Spectrum

Classification	Content
Land Grants	Land grant is issued in accordance with such regulations as Land Development Ordinance, Crown Land Ordinance and Land Redemption Ordinance. Land grant is issued to those who receive a land permit. Recipients are classified as low-income, high-income, peasant, edified youth and Buddhist temples. There are several types of Grant issued under different regulations, such as free Grant, middle class Grant, Land Development Ordinance and special grant. Initial applications are made through Divisional Secretariat. Issuing a Land Grant for special projects, agricultural activities, residents and Buddhist temples.

Classification	Content
Land Permits	Land permit is issued to the selected applicant under Land Development Ordinance and the Western Providence Land Development Statute. The application is submitted through the Divisional Secretaries and approved according to the decision of the Provisional Committee.
Annual Land Permit	Annual Land Permit is issued for short-term agricultural activity and residential use under Crown Land Ordinances. The request is submitted through Divisional Secretariat. Annual usage fee is paid and DoLCG is the income.
Land Release for Department	Land loan for government departments under Crown Land Ordinances. Requests are made through Divisional Secretariat and final approval is approved by the Chief of DoLCG. Issuing loan certificates to selected government agencies.
Long term leasing approval letter	Long term leasing approval letter is issued for 30 years under Crown Land Order. The lender is an individual or institution for residence, agriculture, industry, special projects, and religious places. Applications are made through Divisional Secretariat. Final approval is approved by the professional land ministry.
Long term leasing agreement	Long term leasing arrangement issued after issuing a lease permit to the land recipient under Crown Land Order. It's also a function of land reclamation with long-term leases. Lease returns are granted as part of land commercial activities for DoLCG's revenue activities.
Vesting orders	The vesting order is transferred to a government organization, such as the local authority and the Third Army. H. E. the President approves
Yield tax permits	This is the process of collecting taxes on land that is open to the public on the basis of yield basis. Taxes are collected from auctions for donated and non-donated lands to the government ministries land.
Land Kachchary	Land is given to people through the Land Kachchary. A method of selecting land users by evaluating their land use. The selected candidates are issued as Land Development Ordinance and Grants under the Special Grant Provision Act.

5. ICT Infrastructure Analysis

5.1. Survey Department of Sri Lanka(SDSL) Headquarters

❍ The Survey Department of Sri Lanka's ICT infrastructure operations are as follows:

[Table Ⅲ-20] Computer Infrastructure Operation Status of Survey Department of Sri Lanka (SDSL)]

Classification	Investigation Contents	Note
1. System Operating Organization	Operating team exists, but lacks professional personnel.	
2. Network(External)	LGN (Lanka Government Network, 10Mbps) and Sri Lanka Telecommunication network (20Mbps) are	SLT: 2000 USD LGN: Free

Classification	Investigation Contents	Note
	used simultaneously.	
3. Storage/Backup Policy	There is policy for storage but not for backup.	
4. NMS	None	
5. SMS	None	
6. Access Control	None	
7. Power Supply	Desk top type UPS exists, but it has small volume, and there are almost no power outages in the Colombo district	UPS(30 minutes preservation time)

❍ Subject Regions of Data Center Construction

– Old Server Room located on 3F of the old building checked alternative space due to the problems with bringing in facility, space constraints, and difficulty securing security, but confirmed that existing building is already saturated and it is difficult to obtain a second best option.

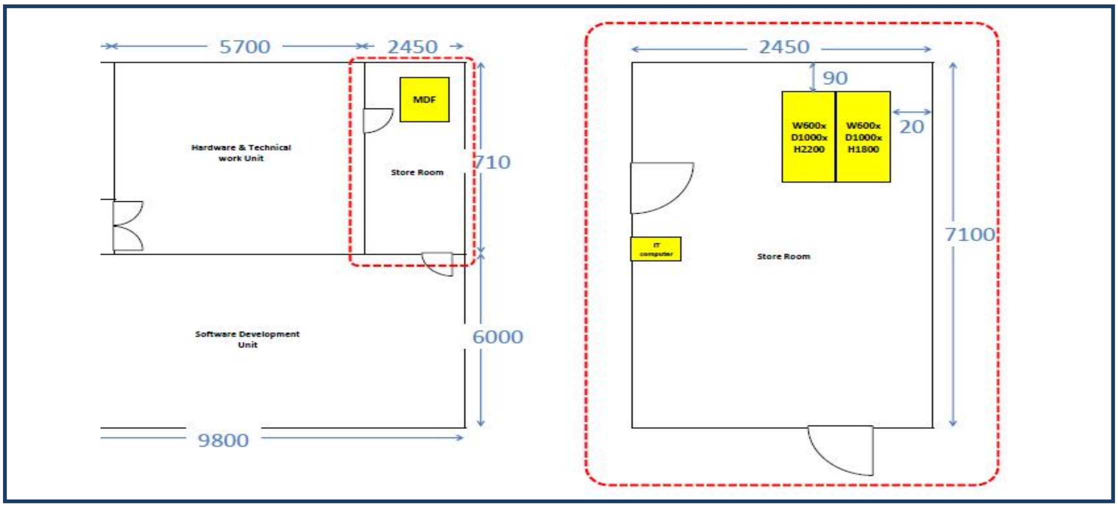
– The LIS Operator anchor location presented at the previous meeting is dedicated to the Data Center because of poor environment in other district offices.

– Environmental requirements such as access control system, fire extinguishing facilities, and Raised Floor are not available.

– Two A/Cs are in shift operation as air conditioning facilities, but no separate plans or humidity control facilities are installed for air circulation.

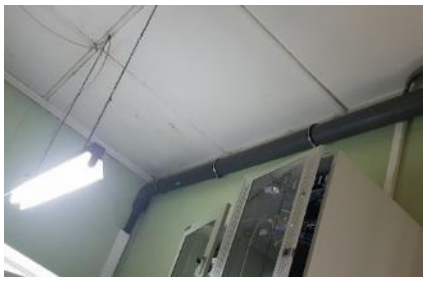
– Old Server Room

- 2.45m X 7.1m space is not suitable for additional rack installations.
- A total of 2 racks are installed, 1 rack is equipped with its own network facility for building services, and the other rack has two LIS Servers in operation and one IT server and storage.
- There is a high risk of future leakage as many Pipe Lines pass through the room.

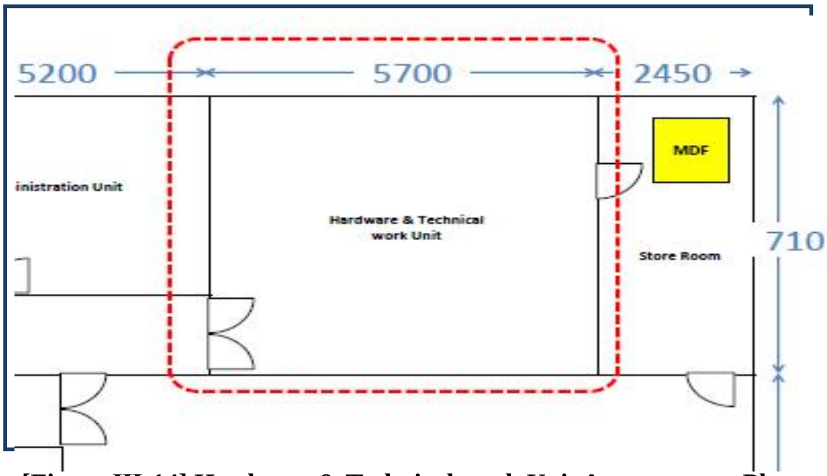


[Figure Ⅲ-12] Arrangement Plan of Old Server Room

– Hardware & Technical work Unit(Replacement Space)

Old Server Room and Environment		

[Figure Ⅲ-13] Environment of Old Server Room and Interior



[Figure III-14] Hardware & Technical work Unit Arrangement Plan

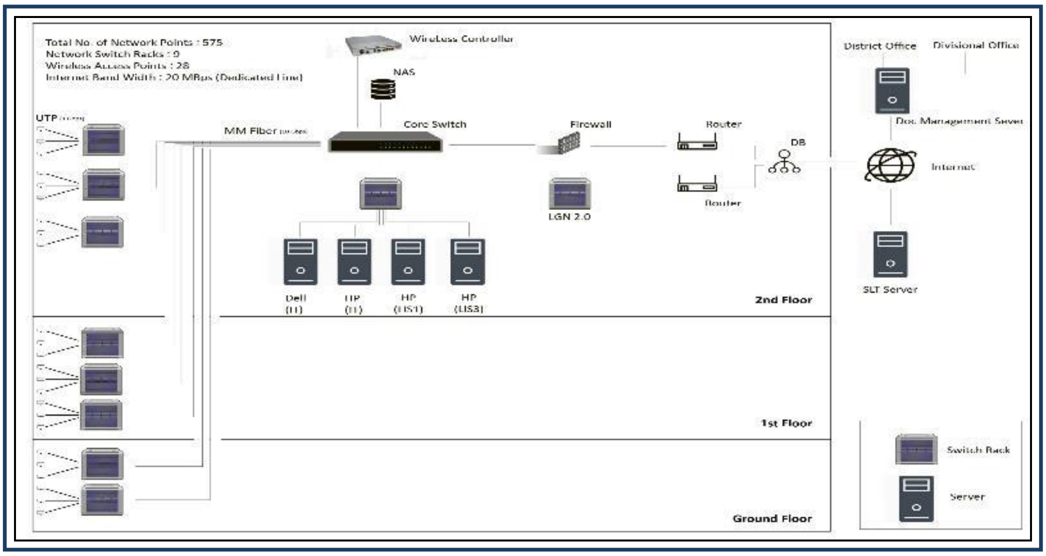
– It is the current anchor location for the personnel of LIS Operation.

– Interior construction such as wall construction and access floor is required, but space of 5.7m X 7.1m allows space to install CABINET 2-layer arrangement, temperature and humidity.

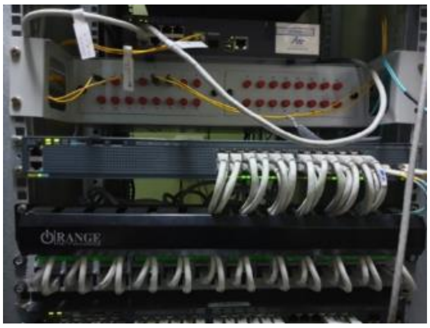
– Old Server Room can be utilized into Ups and Battery Room

❍ Network Composition Status

– Currently, LGN 2.0 (Lanka Government Network) is used as the primary operating network for data upload and download, but it connects the SLT rental network to the VPN in some district offices and division offices, and facilities for both external networks are operated simultaneously.



[Figure Ⅲ-15] Old Network Diagram

SLT and Internal Communication Rack		
LGN 2.0		

[Figure Ⅲ-16] Network Facility Rack

[Table Ⅲ-21] Status of Network Installation

Classification	LGN	SLT
Router	HUAWEI S5300	HUAWEI S5300
Firewall	CHECK POINT 3000 SERIES	SOPHOS CYBERROAM CR 200iNG
Core Switch	CISCO SG300 28MP	CISCO WS-C4500x 16SFPS
Distribution Switch	None	CISCO Catalyst 2960 - X
Wireless Controller	None	CISCO AIR-CT2504
STORAGE	None	Synology RS3617RPxs-12(7/12 used)

❍ Old Facility Status – Server

[Table Ⅲ-22] Detailed Statement of Survey Department of Sri Lanka (SDSL) Server (IT)

Classification	Server 1	Server 2
Host Name	HP-SERVER-PC	IT SERVER
OS Name	Windows Server 2012 R2 Standard	Windows Server 2016 Standard
OS Version	6.3.9600 N/A Build 9600	10.0.14393 N/A Build 14393
Manufacturer	HP	Dell Inc
System Model	ProLiant ML350 Gen9	PowerEdge R930
System Type	x64-based PC	x64-based PC
Processor(s)	2 Processor(s) Installed (Xeon® CPU E5-2640 v3 @ 2.60 GHz)	2 Processor(s) Installed (Xeon® CPU E7-4820 v4 @ 2.00 GHz)
BIOS Version	HP P92, 12/24/2014	Dell Inc. 2.4.3, 7/7/2017
Physical Memory	65,408 MB (64 GB)	32,662 MB (32 GB)
IP Address	-	-
Disk 1 Capacity	1.09 TB	2.75 TB
Disk 2 Capacity	-	-

[Table Ⅲ-23] Detailed Statement of Survey Department of Sri Lanka (SDSL) Server (LIS)

Classification	Server 1	Server 2
Host Name	LISSVR1	LISBRN2
OS Name	Windows Server 2008 R2 Standard	Windows Server 2012 Standard
OS Version	Service Pack 1	6.2.9200 N/A Build 9200
Manufacturer	HP	HP
System Model	ProLiant DL370 G6	ProLiant ML350e Gen8
System Type	x64-based PC	x64-based PC
Processor(s)	2 Processor(s) Installed(Intel64 Family 6 Model 44 Stepping 2 GenuineInt el ~3466 Mhz)	1 Processor(s) Installed(Intel64 Family 6 Model 45 Stepping 7 GenuineInt el ~2394 Mhz
BIOS Version	HP P63, 7/2/2013	HP J02, 8/2/2014
Physical Memory	32,758 MB (32 GB)	8,029 MB (8GB)
IP Address	10.10.10.15	10.10.70.13
Disk 1 Capacity	280 GB	932 GB
Disk 2 Capacity	3725 GB	

IT Server		
LIS Server		

[Figure Ⅲ-17] Old Management Server

❍ Environmental Facility Status

– Old Server Room has two A/Cs in rotation for 12 hours, but facilities for separate humidity management are not reflected.

– Since the current space is small for additional facilities, the expansion of the Data Center requires the reflection of the anti-temperature ventilator.

– Currently, most offices located in IT Branch Office are partitioned, requiring a secure interior when deploying Data Center.

– Access Floor not installed

AA/C & Control		
Combination Lock and Fire Extinguisher		

[Figure Ⅲ-18] Old Server Room Environment Facility

❍ Power Facility

Major Panel Board		
Quarter Panel Board		

UPS		

[Figure Ⅲ-19] Power Facility

– Transformer (CEB; Ceylon Electrical Board) is installed as a separate building on the Ground Floor. Two separate Electrical Rooms are available.

– Since there are no Single Line Diagrams or related electrical drawings due to old facilities, there are many hazards in the area where power lines are drawn into the Data Center by branching from the existing switchboard (it is difficult to check wiring routing and distribution details, so it is not possible to investigate power volumes separately).

– Request to quote that the current Survey Department of Sri Lanka has a separate Single Line as the Data Center destination from the main switchboard through the CEB responsible for electrical maintenance.

– Check the space for installing the Circuit Breaker on the main switchboard in the main electrical room.

5.2. District Survey Office

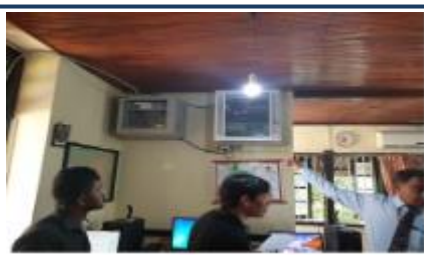
1) Galle District Survey Office

– One A/C is installed (director's office) but not in operation

– LGN 2.0 Government network and SLT rental network are being used at the same time, but there are no operational/maintenance personnel for the facility operation.

– Sub-Network not configured

– Due to the overall aging of the building, it is very difficult to create an environment for installing additional Facility (Input Power: Single Phase 220V (MCB: 32 A).

District Office Operation Status		
		

[Figure Ⅲ-20] Galle District Survey Office

2) Kandy District Survey Office

- New buildings are located adjacent to old buildings that are being used as existing workspaces and/or installed/operated by the office next to the LGN network cabinet.
- LGN 2.0 Government network and SLT rental network are being used at the same time, but there are no operational/maintenance personnel for the facility operation.
- No sub-network is currently configured, but additional configuration requests are requested for file sharing and use of Network Printer (businessperson)
- Input power: 3 Phase 415V (MCB: 60 A)

District Office Operation Status	

[Figure Ⅲ-21] Kandy District Survey Office

3) Anuradhapura District Survey Office

- Site is the most efficient use of LGN 2.0 government network, and SST rental network is only used at the Manager level. Sub-network is not configured/operated separately due to the lack of SLT rental network.
- Furthermore, without IT personnel, they are well-versed in the overall use of government networks and have no objections to limited capacity.
  Request Intra-Net configuration because some office space is out of LGN Coverage
- Document Room is to be expanded (2020)
- Input power: 3 Phase 415V (MCB: 63 A)

District Office Operation Status	

[Figure Ⅲ-22] Anuradhapura District Survey Office

4) Kurunegala District Survey Office

- Due to lack of understanding of LGN 2.0 government network, it is mainly used for SST rental network.
- Issues have been raised about the limited capacity of the government network that charges only 12GB/months per account, but it has been confirmed that there are no institutional connections.
- No operational/maintenance personnel for IT facility operations.
- Currently, Sub-Network is configured and used, but the related drawing or history cannot be viewed. Majority of the wired cables are unavailable.
- Insufficient input power to use the A/C (second phase) held at all. Multiple Power Failure sightings during field visits (Input Power: Single Phase 220V (MCB: 32 A))

District Office Operation Status	

[Figure Ⅲ-23] Kurunegala District Survey Office

5) Rathnapura District Survey Office

- Although LGN 2.0 government network and SLT rental network are provided at the same time, there are no operational/maintenance personnel for IT facility operation just like other District offices.
- Currently, Sub-Network is configured and used, but the related drawing or history cannot be viewed. Majority of the wired cables are unavailable.
- Using separate Laptop due to old PC for Bim Saviya work
- Currently 100 pages/Month uploading drawings related to Bim Saviya
- Input Power: Single Phase 220V (MCB: 32 A)

District Office Operation Status	

[Figure Ⅲ-24] Rathnapura District Survey Office

6) Gampaha District Survey Office

– LGN 2.0 Government network and SLT rental network are provided at the same time and are effectively allocated and used for the purpose of use.

– It is dilapidated by using sub-network at the bottom of the SST rental network or by a local company. It cannot be maintained as it does not have related drawings/diagrams.

– No operational/maintenance personnel for IT facility operations

– Old buildings are difficult to obtain separate routes for indoor wiring and high Ceiling makes exposed piping/wiring seem appropriate when considering maintenance (same as other district offices).

– Since most of the Division Survey Office is located in private buildings, LGN's network is not connected. Therefore, cadastral data prepared by applying SLT rental network is being uploaded to HQ Office (Input power: 3 Phase 415V (MCB: 32 A)).

District Office Operation Status

[Figure Ⅲ-25] Gampaha District Survey Office

7) Polonnaruwa District Survey Office

– No operational/maintenance personnel for IT facility operations

– Main Use Network: LGN 2.0

– Number of PCs in operation (Management/Survey Work) : 10

– Usual power outage time and recovery time: 3 times a week, within 2 hours

– Input power: 230V (MCB: 40A)

District Office Operation Status

[Figure Ⅲ-26] Polonnaruwa District Survey Office

8) Trincomalee District Survey Office

– No operational/maintenance personnel for IT facility operations

– Main Use Network: LGN 2.0

– Number of PCs in operation (Management/Survey Work) : 11

– Usual power outage time and recovery time: 3 times a week, within 2 hours

– Input power: 230V (MCB: 40A)

District Office Operation Status

[Figure Ⅲ-27] Trincomalee District Survey Office

9) Batticaloa District Survey Office

District Office Operation Status

[Figure Ⅲ-28] Batticaloa District Survey Office

- No operational/maintenance personnel for IT facility operations
- Main Use Network: LGN 2.0
- Number of PCs in operation (Management/Survey Work) : 10
- Usual power outage time and recovery time: once a week, within two hours
- Input power: 230V (MCB: 40A)

10) Ampara District Survey Office

- No operational/maintenance personnel for IT facility operations
- Main Use Network: LGN 2.0
- Number of PCs in operation (Management/Survey Work) : 10
- Usual power outage time and recovery time: 5 times a week, 1 hour recovery
- Input power: 230V (MCB: 40A)

District Office Operation Status

[Figure Ⅲ-29] Ampara District Survey Office

11) Matale District Survey Office

- No operational/maintenance personnel for IT facility operations
- Main Use Network: LGN 2.0
- Quantity of operating PCs (Management/Survey Work) : 9
- Usual power outage time and recovery time: 3 times a week, 15 minutes or less
- Input power: 230V (MCB: 40A)

District Office Operation Status

[Figure Ⅲ-30] Matale District Survey Office

12) Nuwara-Eliya District Survey Office

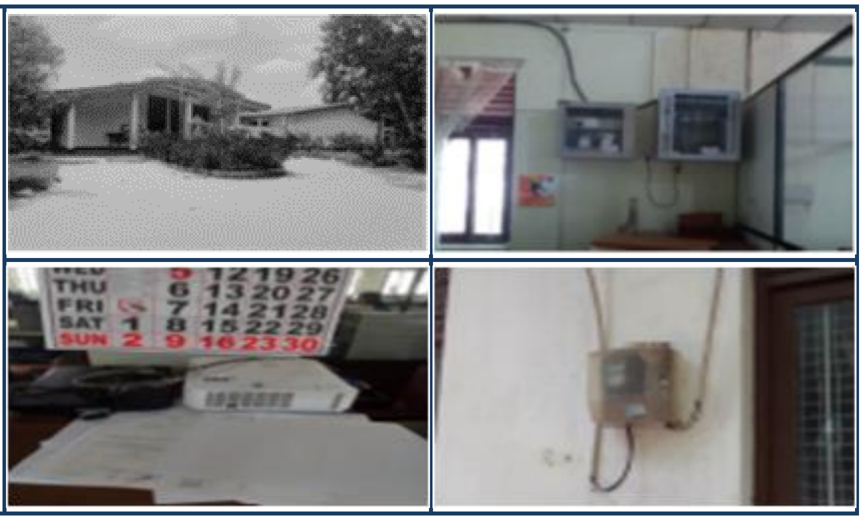
- No operational/maintenance personnel for IT facility operations.
- Main Use Network: LGN 2.0
- Number of PCs in operation (Management/Survey Work) : 10
- Usual power outage time and recovery time: once a week, in less than 50 minutes.
- Input power: 230V (MCB: 40A)

District Office Operation Status

[Figure Ⅲ-31] Nuwara-Eliya District Survey Office

13) Puttalam District Survey Office

- No operational/maintenance personnel for IT facility operations
- Main Use Network: LGN 2.0
- Number of PCs in operation (Management/Survey Work) : 11
- Usual power outage time and recovery time: 2 times a week, 10 minutes or less
- Input power: 230V (MCB: 16A)

District Office Operation Status	

[Figure Ⅲ-32] Puttalam District Survey Office

14) Kalutara District Survey Office

District Office Operation Status	

[Figure Ⅲ-33] Kalutara District Survey Office

- No operational/maintenance personnel for IT facility operations
- Main Use Network: LGN 2.0
- Quantity of PCs in operation (Management/survey task): 13
- Usual power outage time and recovery time: once a week, 15 minutes or less
- Input power: 415V (MCB: 32 A)

15) Kegalle District Survey Office

- No operational/maintenance personnel for IT facility operations
- Main Use Network: LGN 2.0
- Number of PCs in operation (Management/Survey Work) : 8
- Usual power outage time and recovery time: 2 times a week, 30 minutes or less
- Input power: 230V (MCB: 30 A)

District Office Operation Status	

[Figure Ⅲ-34] Kegalle District Survey Office

16) Badulla District Survey Office

- No operational/maintenance personnel for IT facility operations
- Main Use Network: LGN 2.0
- Number of PCs in operation (Management/Survey Work) : 11
- Usual power outage time and recovery time: 2 times a week, 5 minutes or less
- Input power: 230V (MCB: 40A)

District Office Operation Status	

[Figure Ⅲ-35] Badulla District Survey Office

17) Monaragala District Survey Office

- No operational/maintenance personnel for IT facility operations
- Main Use Network: LGN 2.0
- Number of PCs in operation (Management/Survey Work) : 10
- Usual power outage time and recovery time: once a week, 30 minutes or less
- Input power: 415V (MCB: 30 A)

District Office Operation Status	

[Figure Ⅲ-36] Monaragala District Survey Office

18) Matara District Survey Office

- No operational/maintenance personnel for IT facility operations.
- Main Use Network: LGN 2.0
- Number of PCs in operation (Management/Survey Work) : 11
- Usual power outage time and recovery time: few.
- Input power supply: 415V (MCB: 60A)

District Office Operation Status	

[Figure Ⅲ-37] Matara District Survey Office

19) Hambanthota District Survey Office

District Office Operation Status

[Figure Ⅲ-37] Matara District Survey Office

- No operational/maintenance personnel for IT facility operations
- Main Use Network: LGN 2.0
- Number of PCs in operation (Management/Survey Work) : 8
- Usual power outage time and recovery time: 2 times a week, recovery within 20 minutes
- Input power: 415V (MCB: 30 A)

20) Jaffna District Survey Office

- No operational/maintenance personnel for IT facility operations
- Main Use Network: LGN 2.0
- Number of PCs in operation (Management/Survey Work) : 7
- Usual power outage time and recovery time: once a week, 15 minutes or less
- Input power: 230V (MCB: 63 A)

District Office Operation Status

[Figure Ⅲ-39] Jaffna District Survey Office

21) Killnochchi District Survey Office

- No operational/maintenance personnel for IT facility operations
- Main Use Network: SLT
- Number of PCs in operation (Management/Survey Work) : 7
- Usual power outage time and recovery time: once a week, 15 minutes or less
- Input power: 415V (MCB: 32 A)

District Office Operation Status	

[Figure Ⅲ-40] Killnochchi District Survey Office

22) Mullaattivu District Survey Office

- No operational/maintenance personnel for IT facility operations
- Main Use Network: LGN 2.0
- Number of PCs in operation (Management/Survey Work) : 6
- Usual power outage time and recovery time: once a week, 15 minutes or less
- Input power: 415V (MCB: 32 A)

District Office Operation Status	

[Figure Ⅲ-41] Mullaattiv District Survey Office

23) Mannar District Survey Office (New Office, No Network Facility)

- No operational/maintenance personnel for IT facility operations
- Main Use Network: SLT
- Quantity of operating PC (Management/survey) : N/A
- Usual power outage time and recovery time: 3 times a week, 25 minutes or less
- Input power: 415V (MCB: 32 A)

District Office Operation Status	

[Figure Ⅲ-42] Mannar District Survey Office

24) Vavunlya District Survey Office

District Office Operation Status	

[Figure Ⅲ-43] Vavunlya District Survey Office

- No operational/maintenance personnel for IT facility operations
- Main Use Network: SLT
- Number of PCs in operation (Management/Survey Work) : 8
- Usual power outage time and recovery time: 3 times a week, recovery in 20 minutes
- Input power supply: 415V (MCB: 40A)

25) Colombo District Survey Office

- Located on the 1st floor of Survey Department of Sri Lanka (SDSL)
- Main Use Network: LGN 2.0
- Number of PCs in operation (Management/Survey Work) : 10
- Normal power outage time and recovery time: few
- Input power: Survey Department of Sri Lanka (SDSL) input power sharing

District Office Operation Status

[Figure Ⅲ-44] Colombo District Survey Office

5.3. Status of Major Organizations

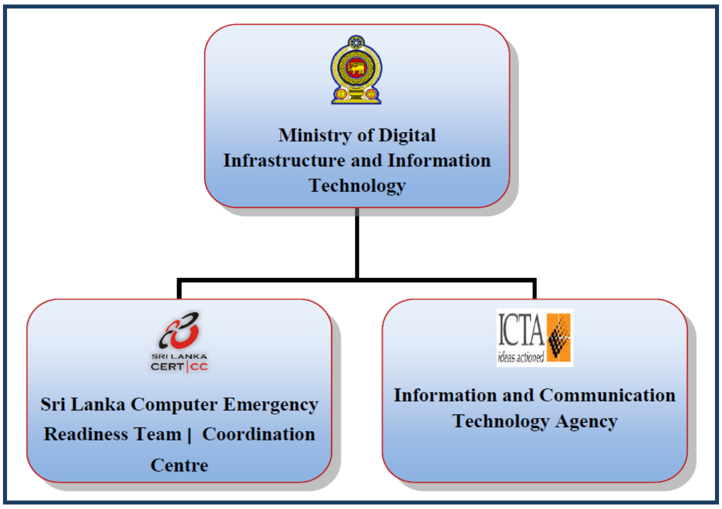
1) Ministry of Digital Infrastructure and Information Technology

- Digital infrastructure and information technology have been identified as two key areas that define the country's future and are in the process of planning for the future.
- Vision, strategy and roadmaps improve citizens' living standards and quality of life.
- Transformation of the Ministry
  - Ministry of Telecommunication and Information Technology (November 22 2015 ~ January 17, 2015)
  - Telecommunication and IT Division in Ministry of Foreign Affairs (January 18, 2015 ~ September 3, 2015)
  - Ministry of Telecommunication and Digital Infrastructure (September 4, 2015 ~ October 26, 2018)
  - Ministry of Digital Infrastructure and Information Technology (December 28, 2018 ~ Current)
- Major Work
  - Establishing, monitoring and evaluating policies, programs and projects related to information communications and digital infrastructure
  - The adoption of modern technology takes the necessary steps to provide communication facilities for everyone
  - Helping the public sector adopt appropriate information technology solutions to promote productivity and efficiency

- Implementation of the Program for the Promotion of Computer Technology
- Develop strategies to encourage the use of information and communication technologies
- Matters concerning all other subjects assigned to institutions listed in the Ministry of Education
- Supervision of institutions listed in the Ministry of Education

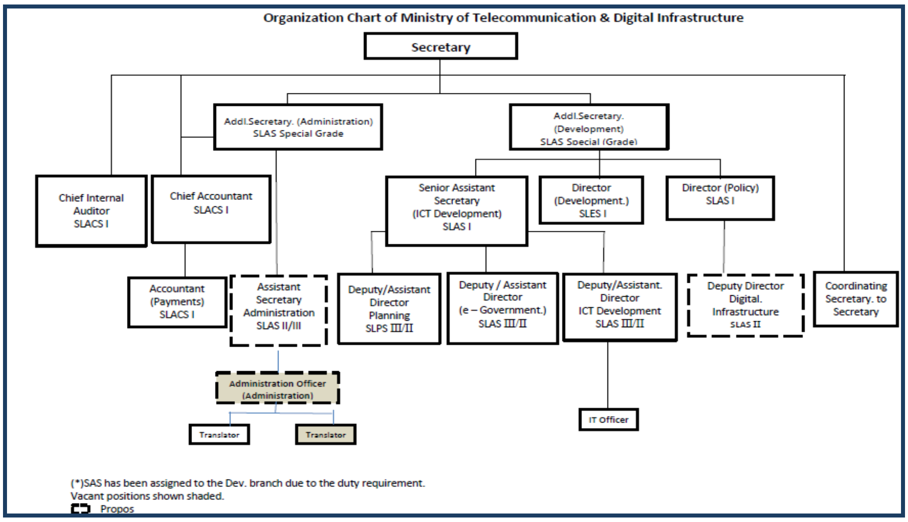
– Subsidiary Organization

- Development Division
- Accounts Division
- Administration Division
- Internal Audit Division
- Planning Unit
- Secretary Office



[Figure Ⅲ-45] Organization Diagram

– Organizational Chart



[Figure Ⅲ-46] Organizational Chart

2) Information & Communication Technology Agency (ICTA)

- Working group for supporting and implementing electronic government policy in Sri Lanka
- Established under the Science and Technology Act in 2003 and upgraded to a presidential office in November, modeled after the e-government promotion system in Korea and Singapore
- After the establishment of the Ministry of Communication and Information Technology in 2010, the organization was functioned under the Ministry of Information and Communication, and ICTA is a permanent institution overseen by Ministry of Telecommunication and Digital Infrastructure, and Inter Ministerial Committee currently.
- Major Role
  - Establishing, implementing national ICT policies and implementing e-government-related tasks
  - Establishing consulting guidelines for implementing ICT policies
  - Conducting consulting on ICT activities and requirements of relevant government organizations

3) Lanka Government Information Infrastructure (LGII)

- Lanka Government Information Infrastructure (LGII) is a wholly-funded subsidiary of Sri Lanka's ICT Organization (ICTA), responsible for the operation and development of the Lanka Government Network (LGN), a networking infrastructure that interconnects various government agencies and provides government electronic services.
- Connects more than 500 government organizations in Sri Lanka and provides IT-related services to the government.
- LGII facilities include LGN hubs hosting state-of-the-art Network Operation Center (NOC) and help desk, which includes a number of servers, network monitoring and management that serve as interconnect points for various end sites.
- Operates 24 hours and can communicate in three languages: Sinhala, Tamil, and English.
- Services provided by LGII to government agencies include LGN connectivity and related services, Internet access, Voice over IP (VoIP) service, and registration of all domain names in the gov.lk domain.

5.4. NDC(National Data Center)

❍ Overview

- Location: Techno City, Pitipana, Homagama.(32 km from Colombo City boundary)
- In progress of operating and maintaining Sri Lanka Telecom (SLT)
- Sri Lanka's largest Internet Data Center (IDC), which has a floor space of 63,000 ft2 in an area of 20,000 acres.
- Tier III & Green Gold Certified Data Center
- Available in 500 racks, delivering a total of 2.5MW of IT load
- Power usage efficiency of 1.6 for 100% loading (PUE)
- High scalability and availability with 99.982% uptime

❍ Environmental Facility

– Full Load Backup of Duplexing UPS for 10 minutes, then use Generator Power

– Duplexing 1825 kVA Generator with 48-hour operation

– N+1 duplexing facility (Tier-III Facility)

– Chiller System

– Fire Alarm : Laser based Very Early Smoke Detection Apparatus (VESDA)

– Fire Extinguisher : NOVEC 1230 Gaseous Fire Suppression System

Panoramic View and Rack Room		
Utility		
Physical Security Facility		

[Figure Ⅲ-47] SLT IDC Facility Status

❍ Network Environment

– Accommodating duplexed national backbone network (NBN: National Backbone Network)

– Connecting duplexing optical cables to other data centers of SLT

– 1G/10G Upward Network Speed.

❍ Physical Security Facility

– CCTV Monitoring

– Finger and Palm readers

– Individual cabinet combination lock and Turnstiles (Main Entrance)

6. Level of Technology and Education Status Analysis

6.1. Capability Level of Technology Diagnosis Framework

6.1.1. Introduction of NLCBM-i

❍ The State Land Capacity Building Model for Information (NLCBM-i), developed by the Korea Land and Geospatial Informatix Corporation, is a model that systematically supports roadmaps for enhancing land information capabilities and human capabilities plans.

❍ This model provides framework, diagnostic assessment tools, and capacity building tools for pre-survey, provides specific survey targets, criteria for evaluation, and is a tool to define the current level through in-depth investigation and diagnostic evaluation to provide customized curricula and roadmaps.

6.1.2.Method and Application of Capability Diagnosis

❍ NLCBM-i's investigative framework consists of three components and seven sub-components.

❍ Using a pre-designed checklist, in-depth questionnaires are conducted through a sophisticated question system, and components are systematically reviewed in line with the checklist. The components consist of land information governance, land information infrastructure, and land information technology. The sub-components consist of legal system, data, system, facility equipment, survey and data acquisition, system development, database construction and management.

Component	Sub-Component	Status
Land Informatization Governance	Law & Policy	Documentation
Land Information Infrastructure	Data	Digitization
	System	
	Equipment & Facility	
Land Information Technology and Knowledge	Field Survey & Data Acquisition	Digitization
	Database Construction &Management	Documentation
	System Development & Operation	

[Figure Ⅲ-48] NLCBM-i Research Framework Composition Factors

❍ The checklist for capacity diagnosis is prepared by seven sub-components, including law/system, data, system, facility equipment, survey and data acquisition, land database construction and management, and system development and operation.

❍ As a result of capacity assessment, the level of land information service can be divided into three stages: level 1, the documentation stage, level 2 computerization stage, and level 3 land information management stage.

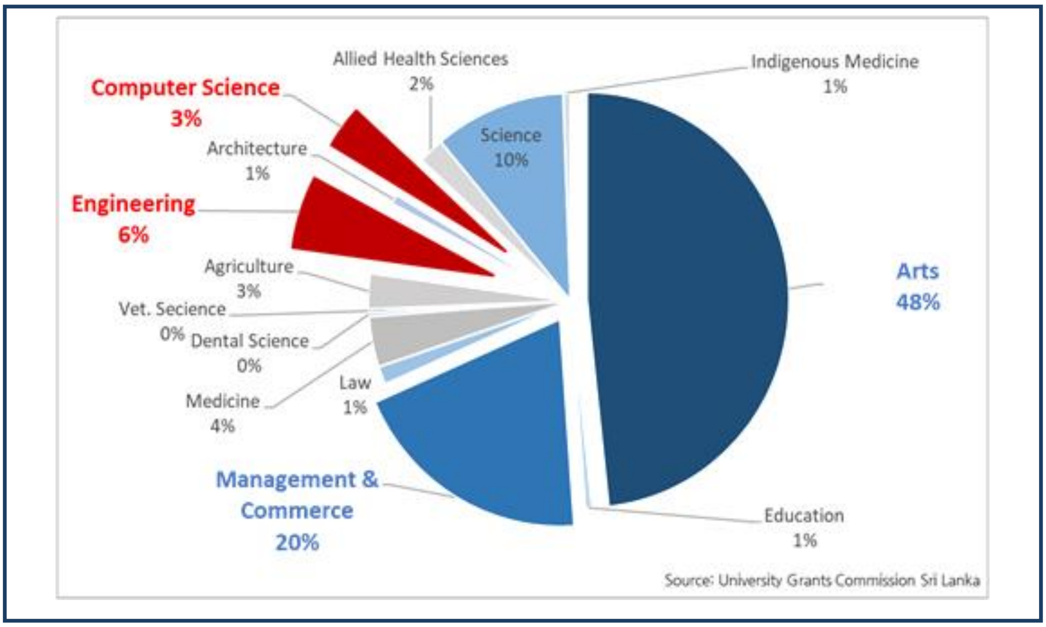
❍ The documentation stage refers to the creation and management of most of the land information as hard copy documents and the use of hard copy documents for land registration and management. The computerization stage is to computerize the hard copy of land attribute information, geography information, and land-related administrative information using a PC. The information management stage is to establish a land administration system and a geographical information system to manage computerized land property information and geographical information. The information utilization phase is to integrate and link land information among land-related institutions through the integration and expansion of the land system. The information convergence phase is to generate spatial information as well as land information using unmanned aircraft and 3D survey equipment and introduce an open data platform to manage, distribute and utilize spatial information.

6.2. Capability Diagnosis and Improvement Plan

6.2.1. Results of Capability Diagnosis

❍ LX consortium conducted an intensive group interview and an in-depth survey of the Land Survey Department of Sri Lanka (SDSL), Land Use Policy Planning Division (LUPP), and Registrar General's Department (RGD), a major organization in charge of the production and management of Sri Lanka's land information, and evaluated the following key findings:

❍ Based on the 2016 statistics, majority of the 28,808 graduates in Sri Lanka have graduated in arts (approx. 48%, or 13,912), with only 3% (946) graduates in computer science or 6% (1,617) graduates in engineering, which are related to land digitization.



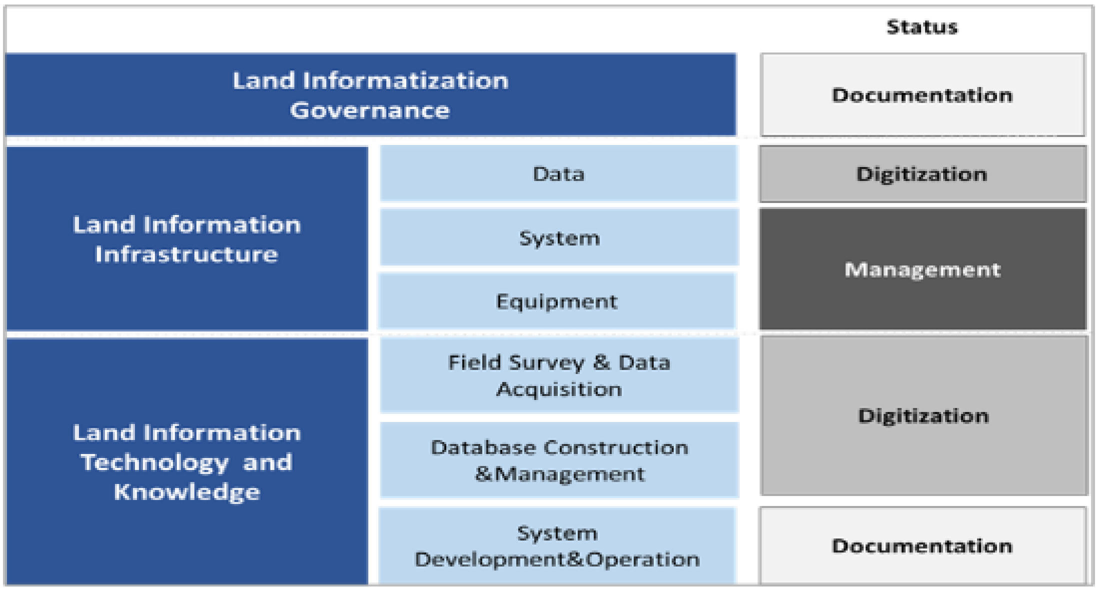
[Figure Ⅲ-49] Ratio of Graduates in 2016 Per Major in University in Sri Lanka

❍ Capability of Individuals and Organizations

– Diagnosis through NLCBM-i shows that Sri Lanka's land information governance is computerizing land information by converting the existing dead system into the Title system when registering land, but because the legal framework for the scope, management system and utilization method of digital land information is insufficient, it is in the first level of documentation stage.

– The data, systems and facilities of the infrastructure are in the information management stage (level 3), and although the ratio of computerized land information is low, the digital data built is easy to update and share, and the administrative information registration management office has established and operated the E-Land Registration System and the Title Registration System.

– Not only is it actively using Total Motion, modern equipment, in the sub-component survey and data acquisition of land information technology and knowledge, but it is also performing satellite surveys such as Static, RTK, and VRS. This is a third level information management stage. However, the deployment and management of lower component land DBs, system development and operation are in the computerization stage (level 2). It is analyzed that the system/data architecture and standardization are not established, and that the web system development, data construction and management lacks its own capabilities.



[Figure Ⅲ-50] Level of Capability of Land Digitization in Sri Lanka

① Survey and Data Acquisition Technology Capability

– In order to advance to the information management stage (level 3) of the current computerization stage (level 2) as a result of diagnosis, the technical competency in this section must be strengthened based on the evaluation basis below.

– First, in the area of survey techniques, whether or not the methods for survey are being used for cadastral survey work and what stage they are at through questioning about the Post-processing method of survey data were identified.

– The total station is used for cadastral survey by the Survey Department of Sri Lanka and post-processing of survey data is performed through ZWCAD software, which has been identified as a computerization stage. This office is using AutoCAD, which is most commonly used, and ZWCAD is still in use in the Division Office. To improve work efficiency and to be compatible with the Land Information System, it has been confirmed that education on utilizing various CAD programs, including open source, is necessary.

– In addition, Sri Lanka's national capabilities for collecting aviation and satellite survey data are nonexistent in the land information management stage (level 3), and only a small number of people are able to post-process aviation and satellite images, so that further aerial and satellite image post-processing personnel must be supplemented for future cadastral survey work and national level topography and map production, thus aviation Post-processing training is required.

– Moreover, Survey Department of Sri Lanka has a fixed-income UAV and is using it for survey purposes, but has a very limited amount of resources and staff. Personnel who can use UAV video data post-processing software are also using illegal license versions because they have some of them but are unable to cover high cost software costs. This poses risks such as sudden interruptions, and concerns the use of limited functionality, the biggest drawback of illegal software, so low cost UV data post-processing software and open source-processing software are required. In addition, satellite surveys corresponding to the information sharing/utilization stage (level 4) also operated four teams of expert personnel to support the cadastral metering, but this is not a sufficient number of people for GNSS surveys and is limited in areas where GNSS surveys are available because there are too few permanent stations.

– Second, Sri Lanka was currently operating from 110 national survey control point (1st triangulation point) in relation to whether or not it entered the computerization stage (level 2) in the control point and coordinates technical area. The installation/operation of the control point and the performance of the control point are also well managed, such as completion of the nationwide control point inspection in 1999, so it has been identified as the computerization stage (level 2) in the control point. In addition, given that there are about six GNSS permanent monitoring stations in Sri Lanka in the land information management stage (level 3), but the number of GNSS permanent monitoring stations still remains small and the manpower to operate/manage them is insufficient, and that the installation of GNSS permanent monitoring stations has also been introduced as technology of external developed countries, Sri Lanka is deemed to lack the ability to install/operate its own GNSS permanent monitoring stations.

– Therefore, additional capacity building for the overall operation of regular observatory is required, and further training for the technical and knowledge workforce to freely transform the provincial coordinate system currently in use into the world coordinate system is also needed to improve the information sharing/utilization stage (level 4).

– Third, in the area of data acquisition, it was diagnosed that the computerization and drawing information was being edited in support of technical skills of external developed countries in relation to whether or not the computerization area (level 2) was entered. In addition, questions were asked about geo-referencing technology and performance personnel to diagnose the information management stage (level 3), and it was found that the technologies such as coordinate transformation and structured editing were not yet actively utilized, and thus the information management stage (level 3) was not entered. According to the diagnosis results, Sri Lanka will have to provide additional capacity building education for the computerization of the entire national territory and the generation of digital land information, along with geo-reference technology education for the efficient use of computerized land information.

② Land DB Construction and Management Technology Capability

– This area is divided into three technical areas: data architecture and standardization, DB software, DB construction and management, and each technology area is evaluated and diagnosed as being in the computerization stage (level 2).

– First, in the area of architecture and standardization technology, documents used in land administration are not standardized by national information standardization through responses from each agency, but documents used for administrative work by different agencies are standardized. In addition, although we have some data architecture knowledge to systematically create/manage computerized data, it has been assessed that it is difficult to manage data actively and that standardization of information has only a plan and has not yet been performed due to lack of infrastructure, thus it was assessed that it was not competent to go to the information management stage (level 3).

– As such, Sri Lanka currently finds it impossible to share, link and utilize effective data due to the lack of systematic database construction and information standardization, so it has to combine technical training for data architecture with technical knowledge training for information standardization, and additional skills training such as DB design should be conducted in order to improve the level of information management stage (level 3).

– Second, the DB software technology area was basically using data management software based on the PC, whereas the RGD, which is in charge of land registration, was conducting most tasks manually, and administrative documents were also written by hand, not by PC. Handwritten documents are simply scanned and stored on the PC, making it inconvenient to rewrite when modification and renewal have to be done on data. Thus, for simplicity and efficiency of work, documents must be created/stored and managed using PC-based data creation/management software, which requires competency training in data management software.

– Sri Lanka's land-related institutions are in dire need of PC-based data software training because they are still understaffed to write documents using PCs, and the Survey Department of Sri Lanka and related education institutes have asked for special reinforcement training in this area. Moreover, the introduction of specialized DBMS is essential for managing a large number of computerized data in the future, and training on low-cost open source DBMS and Oracle, a typical commercial DBMS, is required to foster specialized DBMS professionals to utilize DBMS.

– Third, the DB deployment and management technology area was systematically classified and managed documents in step 1 regarding the establishment of the document classification system, and document renewal was basically updated every five years (in case of the capital city, Colombo, data was updated every two years).

– In addition, Land Survey Department of Sri Lanka (SD) was building administrative and other data using the PC-based software MS-Office, but in case of Registrar General's Department (RGD), it was still using analog methods of document preparation and storage, such as manually creating, scanning, and storing the data used in PCs.

– Furthermore, Sri Lanka's land-related organizations believe that they do not use PC-based data software in writing documents, so first, they need to train PC-based basic data-building software for the efficiency of data creation and administrative work on PCs. In order to establish a systematic non-land and land database, the database establishment methodology needs education. In addition, DB S/W training is needed for DB integration management and sharing/connection.

③ System Development and Management Capabilities

– The technology capability in this area has been diagnosed in the documentation stage (level 1) and the assessment results for each technology area are as follows:

– First, in the area of architecture and standardization technology, it was found that Sri Lanka was working in accordance with the standards and standards of procedures for the progress of land work, with clear procedures and criteria for land work.

– In addition, it has been confirmed that no standardization has been established for knowledge and development related to the establishment of the architecture for system construction and operation, concerning the retention of knowledge of the system architecture and development standardization for the purpose of determining the entry into the computerization stage. Therefore, it is deemed that Sri Lanka needs education such as establishment of integrated system for land information service and standardization, standardization of system design, standardization of system architecture education related to project registrations and systems, design, etc. in order to train professionals with knowledge of integrated system development and standardization.

– Second, the system development technical area assessed the ability of GIS engines to be used in future LIS systems by asking questions such as their knowledge of and use of GIS engines that are the basis for LIS system deployment.

– Sri Lanka uses ArcInfo as its most basic GIS software, and most of the agencies that manage and generate land drawing information use ArcInfo, but most of them use illegal licensing versions because they cannot afford high-cost software licenses, and only a small number of people use open-source GIS software.

– As of the illegal licensing software, functions or utilization is lower than the official version, limited use of GIS software still lacks the ability to utilize GIS software, and additional capacity enhancement is required for analysis and generation of high-level land information. Moreover, education on open source GIS software, such as QGIS, should be provided to replace high-cost ArcInfo.

– In addition, technical knowledge of analysis and design for web system development is required as it is necessary to secure specialized IT personnel for web system development and deployment of public service systems that are currently operated only by the Survey Department of Sri Lanka and some agencies to enter the land information management stage (level 3)

- Third, in the area of system operation technology, PC management, network management, and independent department computing rooms, some organizations have applied PC to a significant portion of their work, but some have not done any work through PC.
- The Survey Department of Sri Lanka has separate IT personnel to systematically manage PCs and networks. Except for the Survey Department of Sri Lanka, most land-related agencies have insufficient PC and network management through IT staff, and lack the expertise to manage the computer room. Accordingly, it is deemed necessary to provide basic ICT education for the establishment of computing infrastructure, which is the basis for land information service, and then to require system technology training for the management, operation and maintenance of stand-alone computer rooms.

6.2.2.Education Infrastructure Status Analysis

Interior of Training Field (Production Room of Topographic Map)

Exterior of Lecture Room

[Figure Ⅲ-51] ISM, Panoramic View of Institute of Surveying and Mapping

- Survey Department of Sri Lanka, an institute of surveying and mapping, is located in Diyatalawa, about 200 kilometers from the capital city, Colombo.
- Established in 1969, the government recently implemented 141 million Rupees (approx. 980 M KRW) annually to provide survey and system operation training, 75 full-time regulars annually (for Survey Department of Sri Lanka, ISM education is mandatory as soon as entering position) upon joining, and 100 non-regulars.
- Fourteen instructors are currently teaching two regular courses, two to four years of bachelor's and master's courses, and irregularly visit the institution at the request of the relevant institution and the university without the relevant curriculum, and have been educating for a week or two.
- In total, area of 2.5 km2 consists of main building, 4 lecture rooms, 1 computer room, 2 topographical drawing rooms, 50 dormitories, personnel quarters and guesthouses. Up to 50 people can be accommodated in 1 classroom (no air conditioning, air conditioning facilities, etc. in aging classrooms).

				
Lecture Room A(107 ㎡)	Lecture Room (162 ㎡)	Lecture Room M1(174 ㎡)	Lecture Room M2(126 ㎡)	Computer Room(185 ㎡)

[Figure Ⅲ-52] Panoramic View of Lecture Room

– Although the institute had no problem connecting to the network through LGN (Bandwidth 0-255), it has only native survey equipment and relatively lacks IT-related equipment compared to survey educating equipment (Plug-ins and digitizing tables are not currently in operation and cannot be used).

❍ Related Universities

– Universities with cadastral and land-related education courses are taught mainly in geomatics with two courses (Sabaragamuwa University, Kotasawala Defense University), where they produce a total of 100 graduates a year and are mostly employed as civil servants if they enter this field.

❍ Related Online Education

– Survey Department of Sri Lanka plans to open through the Google Education Platform (Aug, 2019) in preparation for the Survey Department of Sri Lanka Online Training Program (tentative name “Collaboration and e-Learning Platform).

6.2.3. Requirements Analysis

❍ Education Training

– Domestic Education

- The current ISM is being remodeled (four lecture rooms, one computer room, and two production rooms of topographic map), but the target audience is to request inclusion of four central government stakeholders in addition to the target organization.
- Survey and data acquisition is practically all done in the Provisional Survey Office only, but the Survey Department of Sri Lanka is expected to design the training program considering the relatively lower technical capabilities of the Provisional Office personnel than the District.

– Invitational Workshop

- Educating different programs to decision-makers and working-level operators, but like provincial education, the target audience requests inclusion of four central government stakeholder organizations in addition to the target organization.

– OJT(On the Job Training)

- Request for input into projects from the stage of development of four key personnel in each sector (initial six months of business in Korea + 30 months of provincial construction) for smooth operation and strategic training of core personnel after the system is deployed.

– Activation of Online Education

- Request that Survey Department of Sri Lanka utilize Google to review the linkages of EDCF training content to the online training (tentative name "Collaboration and E-learning Platform").

❍ Education Infrastructure-Related Facility

– Environmental Infrastructure: additional 50 armchairs, lecture desk, camera, UPS, audio system, etc.

– H/W: reinforcing computer, projector, smart board, floater, server, workstation, Quadcopter drone, laser printer, movable mic, etc.

– S/W: ArcGIS Desktop, ZW CAD, QGIS, Auto CAD, etc.

7. Projects for Land Informatization

7.1. Bim Saviya project

7.1.1. Overview

❍ In order to overcome the shortcomings of land fraud caused by the existing deed system and to efficiently manage the land, a new Land Management Act (Act 21 of 1998) was enacted in 1998 and applied throughout the entire land, such as land registration and transaction and so on

❍ The Sri Lankan government has implemented a title registration system for five regions with the support of Worldbank (USD 5 million) for the "Land Titling and Related Services Project" (2002–2004)

❍ Establishment of digital land information system through computerization of land information and registration

7.1.2. Project Objectives

❍ Induced title registration system from existing Deed system

❍ Secure land ownership reduces social and economic costs such as land disputes and lays the foundation for individual and national economic development

❍ Build a complete database for efficient management of the country

❍ Digital system construction using land information

7.1.3. Project Scope

❍ Issuance of Title through the role between the Ministry of land and Parliamentary Reforms, SDSL, Land Settlement General, and Department of Land Registrar General's: Surveying is conducted by the Survey Office (SDSL), and ownership investigation is conducted by the Land Settlement Department. After the owner is confirmed, the Title is issued by the Department of Land Registrar 's General. Once title issued, the Title certificate can be reissued and changed information through the Department of Land Register's General

7.2. Land Titling and Relate Services Project

7.2.1. Overview

❍ The project was funded by the World Bank for the Ministry of agriculture, Livestock, Land and Irrigation, with a budget of $ 6.78 million and pilot project for land registration based on a survey of the land settlement department, SDSL and the Department of land registrar's General. The project began in 2001 and was carried out for three years, ending in December 2004

7.2.2. Project Objectives

❍ The project, supported by Worldbank's "Learning and Innovation Loan", monitors the long-term socioeconomic impacts of landowners' land registration, develops capacity for land administration agencies throughout capacity building of agencies and develops legal and institutional frameworks for the Sri Lankan government

❍ Development of support land registration methodology to exercise system functions related to land administration

7.2.3. Project Scope

❍ Improve the efficient management of land records, maximize the function of the Title Registry, minimize title registration time and costs

❍ Improve legal frameworks and develop the required organizational framework and ability to support land management systems, including program planning and project management, organizational development and policy and business development

❍ To this end, in conjunction with the Land Settlement Department, SDSL and the Department of land registrar 's General for an integrated approach to title registration in pilot projects

7.3. Capacity Development Project for Creating Digital Elevation Model Enabling Disaster Resilience

7.3.1. Overview

❍ Sri Lanka is heavily affected by climate change and natural disasters such as floods and landslides. According to the Sri Lankan Disaster management center, flooding is the most dangerous natural disaster that causes thousands of casualties and road losses every year

❍ Sri Lanka established the “Srilanka Disaster Management Act” in 2005, laying the foundation for a systematic management and prevention of natural disasters

❍ The Sri Lankan government has officially requested the Japanese government (Japan International Cooperation Agency) to create a digital elevation model through LiDAR surveying technology to prevent natural disasters (USD 6 million, 2015. 02. ~ 2017. 01)

7.3.2. Project Objectives

❍ The purpose of the project is to create a digital elevation model and transfer the technology to produce a digital elevation model and thematic map that using it

7.3.3. Project Scope

❍ LiDAR surveying and produce digital elevation models for Colombo, Gampaha, Nuwara Eliya, Kegalle, Kandy, and Badulla districts

❍ Training and evaluation of LiDAR data processing and thematic map production technology for SDSL and related organizations

7.4. Digital Topographic Mapping Project for Reconstruction of Northern Region

7.4.1. Overview

❍ Sri Lanka faced urgent issues such as landmine rebuilding and infrastructure rebuilding in the northern provinces after the end of the civil war in 2009

❍ To this end, the Japanese government (Japan International Cooperation Agency) produced aerial thematic maps of the northern provinces and provided data for reconstruction of postwar cities (USD 7.6 million, 2010. 02 ~ 2012. 01)

7.4.2. Project Objectives

❍ Taking aerial photographs of the entire northern provinces of Sri Lanka

❍ Produce 1:10,000 scale thematic map in Mannar and Jaffina District

❍ Transfer of digital thematic map production technology using aerial photographs

7.4.3. Project Scope

❍ Production of digital thematic map
- Aerial photographic survey of 9,000 km2 in the northern provinces
- Create a 1: 10,000 scale thematic map of 2,000 km2 in the Mannar and Jaffina Districts of the North Region

❍ Technology transfer
- Training technics for related officials in SDSL and related organization for GPS photo control

❍ point surveying, leveling, field identification, supplementary field verification, digital photogrammetry(digital aerial triangulation, digital plotting), GIS structuring, and map standardization.

8. Implications

8.1. Land and Spatial Information DB Aspect

❍ Computerization of Old Survey Plans is urgently needed to conform to Sri Lanka's unified SLD99 coordinate system, but in the case of Survey Plans manufactured prior to 1999, a methodology that can be converted and integrated into a unified coordinate system must be established as a result of surveys using old or provincial temporary control points.

❍ To overcome this in a short period of time, we need to establish a methodology to unify the Old Survey Plans into the SLD99 coordinate system by utilizing high-resolution satellite orthoimage for nationwide.

❍ In the construction and utilization of land information, a land data model that can satisfy both the creation, management, joint utilization and land administration of land information must be established, and a data model that is considered as a key data of the national spatial information system in conjunction with buildings and roads.

❍ Currently, buildings and roads in Sri Lanka's major municipal councils are not under unified management due to the diversity of the managing bodies, and are a major stumbling block to the development of a macro-economic framework to secure tax revenue.

❍ Therefore, not only buildings and road information in major municipal councils, but also common-based data should be established to share the information by the managing body. Based on land information, spatial/attribute information of buildings and streets should be integrated and managed.

❍ The competitiveness of national spatial information should be secured through preemptive deployment of data based on the current survey and national spatial information infrastructure in Sri Lanka.

❍ The competitiveness of national spatial information through preemptive deployment of the underlying data should be met not only by computer systems and infrastructure for joint utilization of data, but also by survey infrastructure for continuous updating and managing of spatial data simultaneously.

❍ Although Sri Lanka is planning a CORS network to secure a national level survey infrastructure, it should expand it to a global CORS network as it operates only in the Western Province region on a trial basis, thereby ensuring competitiveness only when the latest survey technology is introduced as well as efficient utilization of survey equipment.

8.2. Task and Application System Aspect

❍ Information sharing between Sri Lanka's land-related organizations (LSD, LUPPD, etc.) is not smooth, and offline-based information sharing system is raising the need for delay and improvement of public service.

❍ As the performance of land survey is collectively managed by the Central Institution (SDSL), the work performance and process is under heavy load, and the proper distribution of work is required by district offices.

❍ There is not enough cadastral information sharing systems in use, and the operating infrastructure of the system is very poor (e.g., it takes approximately 1 minute for the tablet registration to display a written map via LIS).

❍ Since spatial information such as buildings and roads that are required for sharing and use of cadastral property is not distributed, the degree of cadaster is very limited (which does not serve as a multi-purpose cadastral property).

❍ Land segmentation results carried out by private surveyors in the Bim Saviya region are being submitted to the District Survey Office directly, costing a lot of money and time.

❍ In case of division of private property within sporadic districts, the problem of coordinate system conversion is expected when surveyors upload the results of the private land split survey to the system in the future using individual coordinate system.

❍ As there is no link between system operated by relevant agencies, the information distribution is inefficient, and the system linkage is required.

– Adequate link between ICTA's e-LG system and the SDI infrastructure
– Linkage of Land Information with the Provincial Land Management System (eSLIMS) of DoLCG
– System linkage between SRIMS and TLDMS in SDSL

❍ Capabilities is enough to perform project and O&M through experiences in a number of national informatization projects.

8.3. ICT Infrastructure Aspect

❍ Existing System Facility

– Although the facility improvement work was carried out in parallel with the construction of the Land Information System (LIS) through ICT companies to supply the internal private network of the Survey Department of Sri Lanka (SDSL), the current state is extremely underutilized as a Main Data Center for the operation of the land information system due to insufficient space area and environmental conditions.

– Fiber Optic cable (16 cores) for SLT's rental network is being supplied with LGN 2.0 as a core only, but redundancy is required to improve stability.

– Currently, it is necessary to utilize a separate space adjacent to the environment and facilities of the Intermediate Distribution Frame (IDF) room level of the large building as an equipment room and operating room of the new system.

– Nevertheless, it is necessary to take countermeasures to prevent disruption of operation services during the facility improvement construction period.

❍ Provincial Office

– Located in nine states listed in the Project Concept Paper (PCP), the Provincial Office performs only local personnel and administrative management tasks, but is not relevant to the actual survey and has no infrastructure for the configuration of the computer room or the server room.

– Among provincial offices, District Survey Office is provided with LGN 2.0, a government administrative network, and offices are connected to local nodes via optical cables, which are suitable for long-term integration.

– Simultaneously provided Sri Lanka Telecom rental network is provided by Asymmetric Digital Subscriber Line (ADSL) to the east and north, although SLT rental network is provided through optical cable for offices located on the west coast of the metropolitan area due to large regional variations.

– Nevertheless, the government network provided by wireless network is installed without measuring/reviewing coverage, so the reception rate is low locally and the available area is also using the network through a separate receiver, causing some points of failure.

❍ To improve the environment of provincial offices, the government network is being streamlined (internal private network) and some old operating equipment is considered to be replaced.

8.4. Management and response measures for successful execution

❍ Since the establishment of a unified coordinate system, the establishment of integrated land information including spatial/attribute information of buildings and roads, and the introduction of the latest survey equipment and technology using the CORS network, experts of the relevant fields must be dispatched to carry out and supervise the project thoroughly.

❍ In addition, since the results of land division should be submitted online to reduce the cost and time, solve the problem of coordinate system conversion that may occur when updating survey results using a unified coordinate system, and share data by linking the related agencies, the redundancy of the network is necessary to improve the stability of the system to be built through the user-oriented project, and some measures to prevent the system from being replaced during the facility improvement period.

❍ Once the project is completed, we expect the following improvements to be made:

– The sharing of information among land-related agencies to be more active
– Online-based information sharing system reduces business delay
– Expect to see a significant improvement in public service

Ⅳ. Analysis of Similar Previous Projects

1. Examination and Analysis of Similar Projects

1.1. Advanced Case of Cadastral (Land) Digitization and Management System

1.1.1. Digitization of Cadastral Terrier

❍ Background and Purpose of Digitization of Cadastral Terrier

– To accurately and quickly obtain land ownership information to secure the basic policy data for preventing real estate speculation and stabilizing land prices

– To digitize land register as part of the priority projects of the first national administrative computer network, thereby providing online services nationwide and revolutionize public services

– To set up a digital cadastral system for all lands across the country and a comprehensive land information network, thereby laying the groundwork for the real name registration system for real estate properties for stabilization of land prices and prevention of speculation

❍ Process and Description of Digitization of Cadastral Terrier

– The purpose is to digitize land register data on 35 million parcels nationwide and to set up and operate the National Land Information Center, which integrates the digital registration data on 43 million residents from the Ministry of Interior and digital data on the officially assessed land prices of 26 million parcels from the Ministry of Construction and Transportation.

– Digitization of land (forest land) register began in 1976, and online services were launched in 1990.

※ Source: Chae Gyeong-seok 2001, A Study of Cadastral Digitization and Direction of Development

[Table IV-1] Process of Digitizing Land Records in Korea

Stage		Description
Preparation (‘75~86)		- Creation of land (forest land) register card - Organization of list of resident registration numbers of landowners - Organization of units used to indicate area and convert into metrics - Organization of existing data
Setup (‘82~90)	Stage 1	- Introduction of city, provincial and central computer systems - Input of land (forest land) register information
	Stage 2	- Securing of a digital organization and establishment of a digital communications network - Software development and data organization

Stage		Description
Operation ('90~)	Stage 1	- Online services provided nationwide - Abolition of land (forest land) register card system - Supplementation of new program creation and application software features
	Stage 2	- Replacement of the main computer system (Ticom -> Domestic computer system) - Data set up in si/gun/gu (city/county/district) offices through comprehensive administrative digitization of si/gun/gu offices - Data conversion for si/gun/gun offices(C-ISAM --> RDMS)

1.1.2. Digitization of Cadastral Maps

❍ Background and Purpose of Digitizing Cadastral Maps

– Overcome the inefficiency of land management caused by cadastral terrier-centered information that is separate from the cadastral maps and improve public services

– Need to digitize cadastral maps and ensure accuracy of the cadastral maps because a variety of thematic maps need to be produced based on cadastral maps and cadastral maps need to be attached to many civil documents

– Need to digitize cadastral maps in order to effectively provide public services such as retrieving and issuing cadastral maps and copies thereof, which take too much time and manpower due to the insufficient digitization of cadastral maps, even though the land (forest land) register has been digitized

❍ Process of Digitizing Cadastral Maps

– Pursue integration of cadastral terrier and maps through digitization of cadastral maps because separate digitization of the land register and drawings has led to inefficient land management

– Set up a database of 720,000 cadastral and forestry maps between 1998 and 2000 by digitizing cadastral maps as part of the 1st National GIS Project

❍ Method of Digitizing Cadastral Maps

– Apply the digitizing method or scanning method based on the preservation state of the drawings

– Digitizing is a method of creating a computer file using a coordinate reader to obtain the boundary points of each parcel when the drawing is severely damaged

– Scanning is a method of creating a computer file by generating an image file of the drawing using a flat scanner and performing vectorizing when the drawing is in relatively good condition

1.1.3. Establishment of PBLIS[23]

❍ Background and Purpose of Establishing PBLIS

- A spatial information system was established for the purpose of promoting the use of cadastral maps in accordance with the first master plan for the national GIS and the project was completed for 254 si/gun/gu nationwide from 1996 to 2002.
- Because there was an urgent need for digital cadastral data in various fields requiring land information, unit cadastral map information and attribute data built individually to meet such demands were integrated.

❍ Description of PBLIS

- A project to set up a system that integrates the results of the cadastral map digitization project aiming to digitize the existing cadastral (forest) maps with the land (forest) register, i.e. graphic and attribute data

1.1.4. Establishment of LMIS[24]

❍ Background of Establishing LMIS

- Eliminate inefficiencies in land administration in relation to regulations on land ownership, transactions and usage, development, and management handled by local governments caused by complex and analog processing
- Provide accurate land information, improve the productivity of public servants concerned, and prevent wasting of money caused by redundant development of information systems of multiple local governments
- Set up a comprehensive information system that can organically link land-related tasks prescribed by individual statutes and systematically integrate and manage spatial, attribute and legal data related to land so as to allow swift acquisition of accurate information necessary for establishing a practical land policy

❍ History and Establishment of LMIS

- For LMIS, various zoning maps were created based on the cadastral maps that have been edited by using serial cadastral maps in combination with topographic maps and then they were integrated with attribute and legal information.
- Since 1998, the comprehensive land information network project was completed in 2005 through a pilot project in Nam-gu, Daegu and a project to disseminate the network.
  Source: MOLIT National Spatial Information Center, 2013

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23 PBLIS: Parcel Based Land Information Syste

24 LMIS: Land Management Information Syste

[Table Ⅳ-2] History of LMIS

Category	Year	Target area	Note
Pilot project	1998	Nam-gu, Daegu	
1st dissemination project	1999	12 si/gun/gu incl. Gangnam-gu, Seoul	
2nd dissemination project	2000	4 metropolitan cities and provinces (Seoul, Busan, Jeollabuk-do Province, Jeju-do Province) and 56 si/gun/gu	
3rd dissemination project	2001	5 metropolitan cities and provinces (Daegu, Gwangju, Daejon, Jeollanam-do Province and Gyeongsangnam-do Province) and 58 si/gun/gu	
4th dissemination project	2002	3 metropolitan cities and provinces and 32 si/gun/gu	
5th dissemination project	2003	3 metropolitan cities and provinces 42 si/gun/gu	
6th dissemination project	2004	1 metropolitan city/province and 1 si/gun/gu	

– LMIS was promoted as part of the following five strategic projects:

- Improve the institutions such as the related laws, regulations and guidelines for making a transition from the existing analog technology to digital information technology
- Set up spatial information infrastructure such as basic land data necessary for local governments to carry out land administration
- Apply open component technology due to the use of different software, hardware and operating system platforms by local governments
- Establish cooperative partnerships to digitize the land administration tasks performed by various departments
- Cultivate a digitization mindset such as providing education and training to system users

1.1.5. Development of KLIS[25]

❍ Background of Establishing KLIS

– Enhance work efficiency by improving the convenience of system operation by integrating the PBLIS of the Ministry of Interior for carrying out the existing cadastral services and the LMIS of the Ministry of Construction and Transportation for land services

– Ensure data integrity through integrated management of cadastral map database

– Improve the efficiency cadastral- and land-related civil services by enabling online services through nationwide operation of KLIS following the establishment of the foundation for online issuance services

25 KLIS: Korea Land Information Syste

❍ Characteristics of KLIS

– Integrate the PBLIS and LMIS and unify the functions of the road name and building number management systems that have been developed in structurally different ways across the nation

– Build attribute data pertaining to land characteristics, officially assessed land prices, the history of real estate agents, etc. and spatial databases of topographic maps, cadastral maps, serial cadastral maps, zonings, etc. in one integrated server

– The composition and functions of KLIS are shown in the following table:

[Table IV-3] Composition and Functions of KLIS

Category	Functions	Category	Functions
Cadastral records management	- Land alteration management - Cadastral surveying test - Cadastral (general) - Cadastral statistics and policy information - Cadastral map management	Land administration	- Land transactions management - Development burden charges management - Real estate brokerage management - Management of officially assessed land prices - Land acquisition by foreigners
Cadastral surveying	- Triangulation surveying and supplementary triangulation point surveying - Topographic control surveying - Detail surveying	Database management	- DXF file database registration - Shape file conversion - Database consistency check
Preparation of cadastral surveying results	- System support (environment setting) - Survey plans and result of cadastral surveying map	Serial and editing map management	- Serial/editing map organization - Automatic serial/editing map organization
Road name management	- - Road and building management - Building and road name management	Land-related civil application management	- Cadastral- and land-related civil application processing
Zoning management	- Search and history management - Preparation and editing of zoning maps		

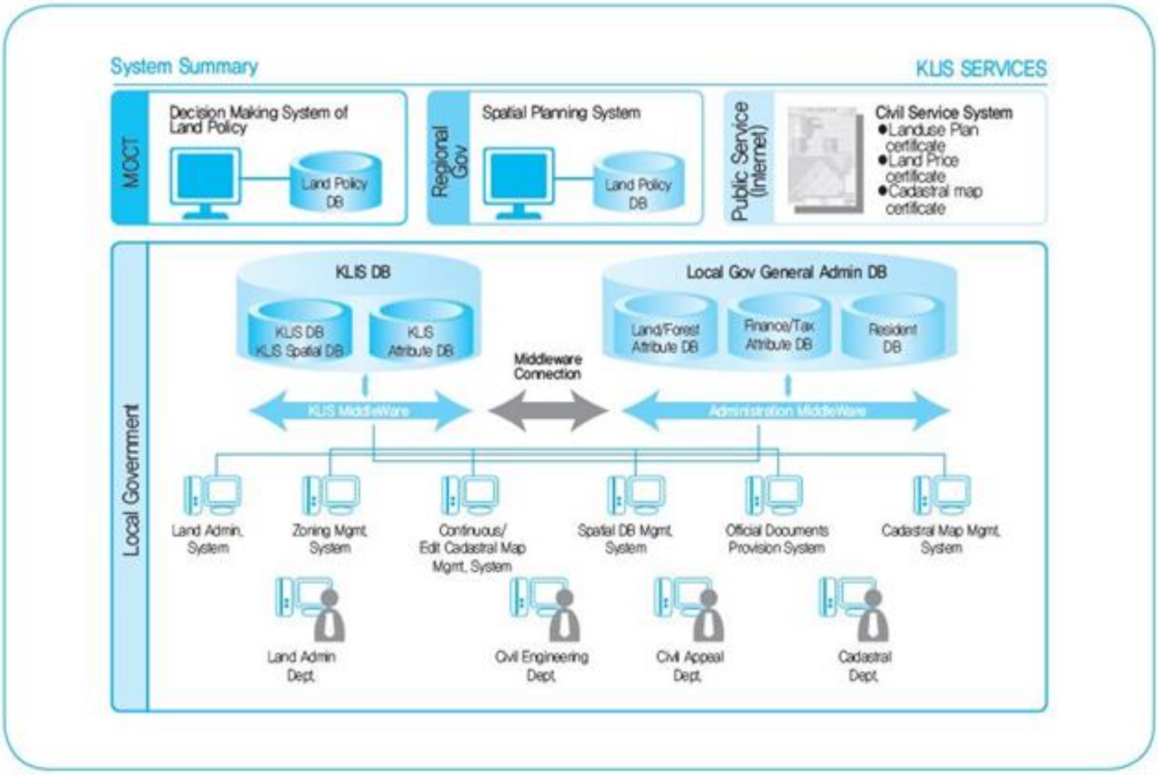
※ Source: Ministry of Construction and Transportation, (2006), KLIS Dissemination Project Completion Report

❍ Composition of KLIS

– The system architecture, application system architecture, data model, etc. of LMIS forming the foundation of KLIS were proposed, and an open architecture was designed because each local government used a different type of server, application, and software.

– The GIS engine was designed as a 3-tier hierarchical system consisting of clients, application servers, databases, etc. while enabling the use of the existing GOTHIC, SDE, and ZEUS.

– The application servers consisted of Web Server, Edit agent, and Map agent.



Source: Korea Research Institute for Human Settlements, 2007

[Figure Ⅳ-1]

❍ Effects of Establishing KLIS

– Digitization of land-related administrative services of local governments resulted in cost reduction and improved reliability thanks to efficient administrative processing of land-related tasks.

– Rational decision-making was enabled thanks to the distribution of various land-related information via the network, which allowed comprehensive search and retrieval of necessary information for reference.

– Cost reduction resulted from preventing redundant investment by eliminating redundant production and management of data.

– It greatly reduced amount of time required for civil services such as issuance of civil documents related to public services and simplified the administrative procedures by connecting them via the computer network.

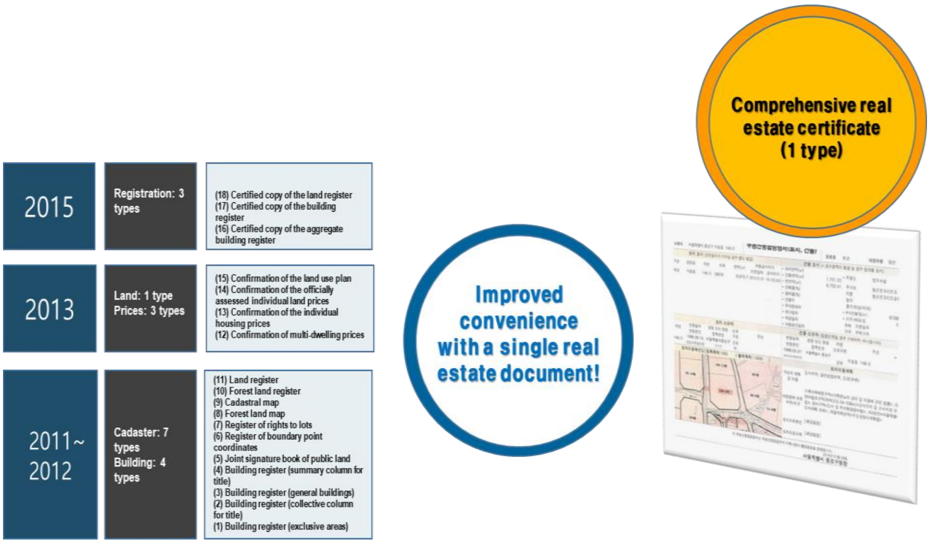
1.1.6. KRAS

❍ Background of Establishing KRAS (Korea Real Estate. Administration Intelligence System)

– 18 types of official real estate books were in use, so applicants had to individually request for the issuance of the documents necessary for approval/permits/licenses via various issuance channels (websites and desks)

– The 18 types of official real estate books managed under the comprehensive official real estate book system (cadastral, building, land use, etc.) were integrated as one to promote administrative innovation and public convenience

– KRAS is a system that manages real estate-related books (cadastral, land, prices, etc.) in an integrated manner, collects and builds information on buildings and registration rights for joint use in administrative procedures, and issues comprehensive real estate certificates for the people.



[Figure Ⅳ-2] Overview of KRAS

❍ Description of KRAS

– KRAS has been in operation since 2014 in 17 metropolitan cities and provinces and 228 si/gun/gu in Korea.

– KRAS was established from 2011 to 2015, and the details thereof are shown in the following table:
※ Source: MOLIT, (2016), KRAS Maintenance, Management and Operation Support Services Completion Report

[Table Ⅳ-4] KRAS Setup

Category	Total	Stage 1		Stage 2	Stage 3	Stage 4	Stage 5
Budget (KRW)	26.39 B	3.2 B	6.2 B	5.89 B	3.63 B	3.56 B	3.91 B
Integration	-	11 types [cadastral (7 types) + building (4 types)]		15 types [land (1 type) + prices (3 types)]	15 types [information convergence]	18 types [register (3 types)]	Encryption of personal information

❍ Effects of KRAS

– It helped simplify unnecessary administrative documents and reduced the burden on the public by providing services to allow people to view comprehensive real estate books and be issued related documents/certificates in an easy and convenient manner.

– It helped ensure the reliability of the new real estate information service system by supporting the maintenance, management and operation of a rapid and accurate comprehensive real estate book system.

– It enabled integrated management of information on real estate, thereby greatly simplifying the administrative procedures of local governments serving the public on the frontline, reducing processing time and eliminating redundant tasks.

– It helped ensure security of personal information included in the real estate books which are important official registers for managing the property rights of the people.

1.2. Analysis of Similar ODA Projects Concerning Cadastral and Land Administration of Developing Countries

❍ Previous projects that are similar to the establishment of a land information system in Sri Lanka were examined to use as reference for implementation of the to-be model of this project and to reflect the experience and knowledge gained from the project to be reflected in the project implementation.

1.2.1.Project for Establishment of Land Information Management System in Kyrgyz Republic

1) Purpose and Scope

❍ The purpose was to contribute to sustainable national land management and economic development through modernization of the Kyrgyz Republic's cadastral system and related capacity building and to provide consulting to improve the cadastral system by dispatching experts capable of ISP development from Korea and analyzing the current status of the current system as well as education and training on project-related administration and GIS, thereby developing the capacity to set up a cadastral system.

❍ The project areas were the Directorate of Cadastral Registration (DCR) of the State Registration Service (SRS) of the Kyrgyz Republic as well as one Bishkek local registration office (LRO) and two Chuy regional registration offices (LROs).

❍ The scale of the project was USD 4 million including PMC service fees of USD 700,000 and PC service fees of USD 3 million. The PMC project period lasted from December 28, 2015 to March 27, 2018 (27 months), and the PC project period lasted from February 16, 2016 to February 15, 2018 (24 months).

❍ The scope of the project included the establishment of an information strategy plan (ISP) for mid- and long-term land informatization of recipient country, local training and training in Korea to build the capacity of public servants in the recipient country, and overall project management. On the other hand, the scope of the PC project was development of a comprehensive land information management system and pilot operation thereof at three local registration offices (LROs) of the DCR intellectual countries such as Bishkek, Ysyk-Ata, and Sokuluk, surveying and geo-referencing in Jalal-Abad and Batken as well as equipment installation and operation.

2) To-Be Model

❍ For the comprehensive land information management system, a switch was made from the existing C/S method to a web-based method, with the main services consisting of service web portal, business web portal, spatial data editing system, data transmission service, data connection service, and map service.

- ❍ Hardware was designed to be three tiers (web servers, application servers, database), with each server made redundant to ensure stability. In addition, it was designed to enable horizontal scalability, and a backup server was added to allow data recovery in the event of system failure. For communication between the DCR and LROs, virtual private network (VPN) and a security solution involving the use of firewalls were applied.

- ❍ The software used is Tomcat for the web server, O2Map Server Engine and JVM for the GIS server, and Tibero for the database server.

3) Implications

- ❍ When it comes to establishing a comprehensive land information management system, the series of processes for establishing an ISP based on an analysis of the current status and setting up a land information system is similar to that of this project; however, the matters concerning the electronic payment settlement system, user authentication system, real estate information linking system, and setup of serial cadastral maps differ from this project.

1.2.2.Project for Establishment of Land Resources Management System in Turkmenistan

- ❍ The Ministry of Agriculture of Turkmenistan allocated the budget for the purpose of boosting productivity through efficient management of agricultural-related lands and systemizing various development plans. The project was conceptualized for the purpose of modernizing land management in relation to agriculture by purchasing and installing the hardware and software as a way to set up a computer system for the capital and each of the 5 velayats, purchasing satellite imagery of Turkmenistan farmlands (30,000㎢), and conducting a land registration pilot project (Ruhabat) near the capital.

1) Purpose and Scope

a) Purpose

- ❍ The purpose was to create digital cadastral maps of agricultural irrigation canals and arable lands found throughout Turkmenistan using satellite imagery and manage them on a computer system, thereby contributing to the modernization of agricultural land management and ultimately improving agricultural productivity.

b) Scope

- ❍ Supply and install equipment (satellite imaging, computer hardware, software, vehicles, GPS, etc.), develop a digital management system for agricultural infrastructure, farmland and agricultural production information, and install a communication system between velayats and Ashgabat

- ❍ Run a pilot project to prepare an agricultural map of Ruhabat etrap in Ahal Province using GIS technology

- ❍ Provide satellite imagery of 30,000㎢ of agricultural lands and related facilities in Turkmenistan

- ❍ Administer education and training on various operations such as GPS surveying, digitization and land information management system for pilot project area

2) To-Be Model

- ❍ The main features of the land resources management system are synchronizing data between the main center and remote centers, interconnecting GPS for field surveys, editing collective farms, parcels and buildings, checking for and correcting errors regarding parcels, and producing various statistical data, and these features were developed based on ArcGIS Desktop.

- ❍ As for the aspect of building data, satellite images and digital maps were included in the system so that they could be used on the land resource management system. In addition, the Soviet Union's 1:200,000 raster topographic map data were purchased and included in the system. Plus, a GIS database structure was implemented in order to build basic GIS data and land resources data necessary for using the land resources management system, and the digital maps created based on high-resolution satellite images of the pilot project area were included in the system.

- ❍ As for infrastructure establishment, GIS/DB server, data server and backup server were set up at the main center of the Ministry of Agriculture of Turkmenistan, which was the recipient entity, while GIS/DB and backup servers were set up at five data centers in the target areas. Workstations and output equipment (plotters and printers) were set up at the main center and provincial data centers for system operation.

3) Implications

- ❍ The project on the establishment of a land resources management system in Turkmenistan involved the development of system features based on ArcGIS desktop, whereas the land information system concerned in this project involves the establishment of a system development plan using open source GIS software.

- ❍ In the case of the land resources management system establishment project in Turkmenistan, the user manual and system management were provided at the same time as system delivery for collective education. In this project, a course for system familiarization and training on system operation is also included in the education and training program.

2. Implications

- ❍ Korea sets National Informatization Strategic Plan, and establishes detailed mid to long term plans and proceed the plans in steps.
  - – For Korea to construct Land Information System, ① Establish basic plan (Master Plan), ② Establish law and system, ③ Proceed in steps according to detailed plans

- Revision of related laws such as cadastral law and enforcement (1975) ➪ Land and forest ledger maintenance (Transform to card ledger; 1976-1980) ➪ Land and forest ledger computerization (1980-1984) ➪ On line service of land and forest ledger (1986-1990) ➪ Research on computerization of cadastral drawing (National Computerization Agency; 1990-1991) ➪ Cadastral drawing computerization experiment project (Changwon-si; 1990-1992) ➪ Cadastral drawing computerization pilot project (Yuseong-gu; 1993-1994) ➪ Cadastral Reinvestigation Project Plan (1995) ➪ Establishment of Parcel Based Land Information System (PBLIS) (1997-2000) ➪ Cadastral drawing computerization project (1998-2002) ➪ Establishment of Korea Land information System (KLIS) (2003-2005) ➪ Establishment of National Spatial Data Infrastructure (NSDI) (2008-2010) ➪ Establishment of Korea Real Estate Administration Intelligence System (KRAS) (2011-2015) ➪ Real Estate Administration Information (KRAS) Unification Service

– Construct long term plan and receive feedback through inspection in steps, reflect and optimize in the detailed plan.

- Maintain continuity, sustainability, and consistency of the project through endless self-reflection and inspection.

❍ As a result of analyzing aid projects for cadastral and land administration in developing countries

– Generally, developing countries were facing difficulties in proceeding plans in stages with long-term plans

- The problems were caused by budget and human resources limitations in developing countries
- Therefore, it is recommended to establish a Master plan and Road map in a medium-term perspective and inspect the process through Mile stones.

❍ Recommended to develop centralized information system and maximize the advantages through the process.

– Development and proceeding of centralized information system prevents duplication of budget investment and waste of human resources and time by maintaining business continuity, sustainability and consistency.

- Implementable on the basis of standardization of business process, data and service through improvement of laws and systems
- However, additional functions / tools such as <Unstructured Statistical Analysis Tool> are needed due to the relatively limited degree of freedom of the system.

❍ It is reasonable to develop centralized information system at the government level for prevention of duplication of budget investment, waste of human resources and time.

❍ After the system is stabilized and sufficient data has been accumulated, it is proposed to establish and spread a decentralized Urban Information System (UIS) in stages, reflecting the characteristics of each municipality.

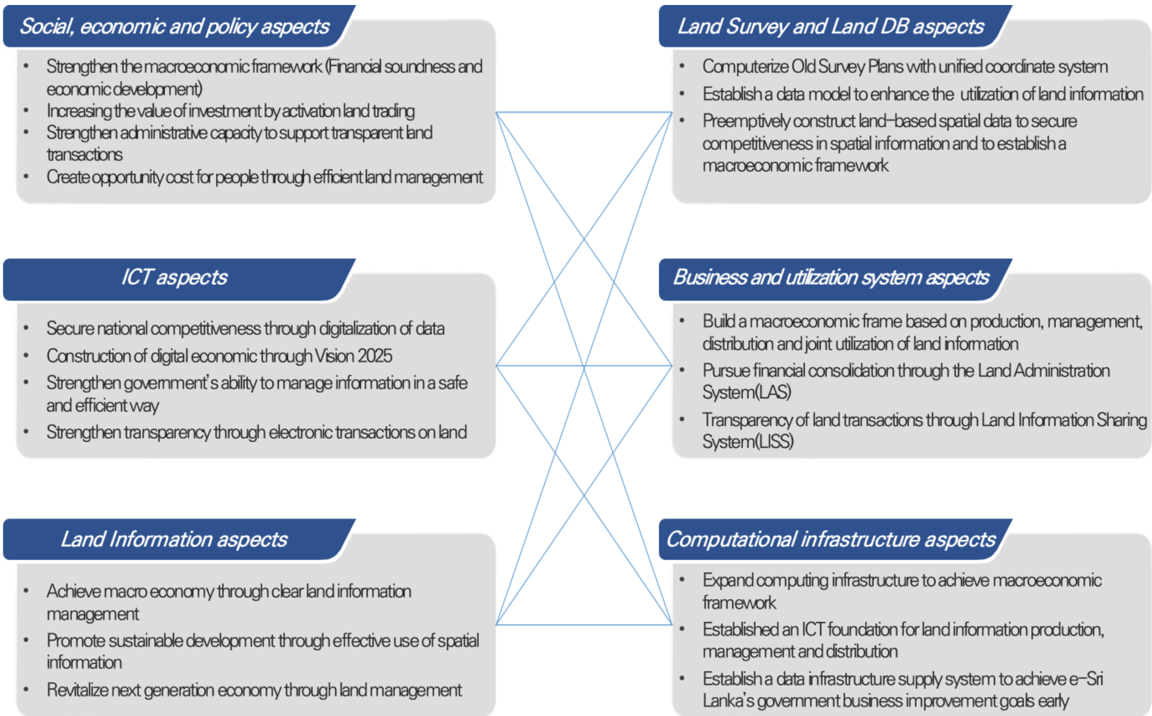
Ⅴ. To-Be Model of LIS and Project Implementation Plan

1. Establishment of Vision for LIS

1.1. Establishment of Future Vision

❍ Establish the future vision of Sri Lanka's Land Information System (LIS) by deriving core values based on an analysis of the current status of Sri Lanka and the target project and combining the keywords that describe the core values.

❍ The implications through current status investigation and target project analysis are linked as follows:



[Figure Ⅴ-1] Connection Between Current Status Investigation and Target Project

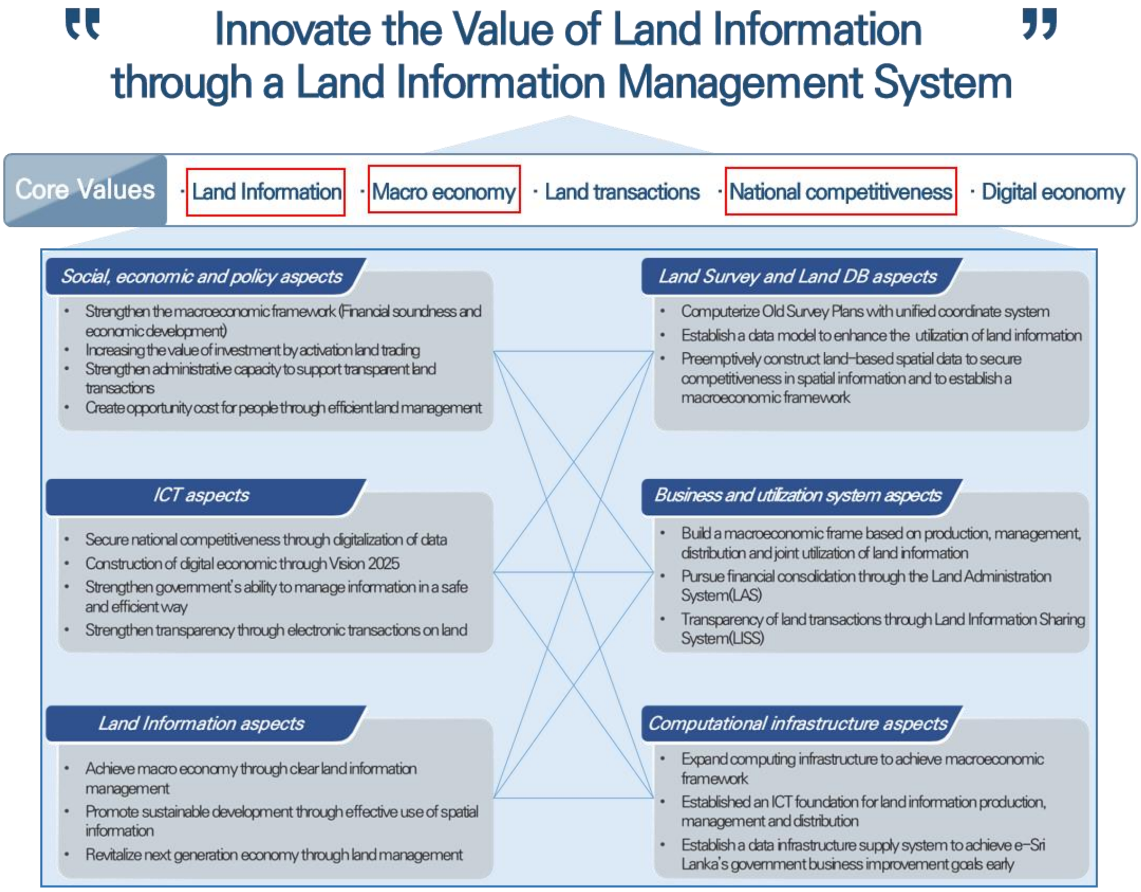
❍ By analyzing the connections between the results of the current status investigation and the target project, it is possible to achieve the macroeconomic framework pursued by Sri Lanka based on the LIS, and this will act to drive forward international competitiveness and national information value innovation through land information.

❍ The keywords for deriving the core values of the future through Sri Lanka's LIS obtained in the process of analyzing the results of the current status investigation and the target project were diverse such as 「land information, national land information, spatial information, land administration, land information system, land transaction, joint use, NSDI, data infrastructure, financial soundness, macroeconomics, international competitiveness, digital economy, economic revitalization, etc.

❍ The core values represented by the keywords are as follows:

① Seamlessly construct land information
② Raise the efficiency of land administration through land information
③ Enable joint use of land information
④ Re-engineering Government through joint use of land information
⑤ Promote land transactions through land information
⑥ Innovate land value through the promotion of land transactions
⑦ Strengthen the competitiveness of Sri Lanka on the international stage through land value innovation

❍ The future vision of the Sri Lanka LIS through the diverse keywords and core values has been derived as “Innovate the Value of Land Information through a Land Information Management System.”



[Figure Ⅴ-2] Future Vision of LIS

1.2. Improvements and Key Tasks

❍ In order to achieve “land information vale innovation through a land information management system,” which is the future vision of Sri Lanka LIS, matters requiring improvement were derived based on issues derived from implications of the target project.

❍ Improvements were derived as follows for the aspects of land administration, land information digitization, data sharing and information utilization, and organizational environment.

[Table V-1] Matters Requiring Improvement

Area	Type	Matters Requiring Improvement
Land administration	Processing	• Need to understand how land administration work is handled among the related agencies • Minimize registration and processing period by omitting and simplifying the gazette procedure • Standardize and unify documents that need to be filled out and simplify signature/seal items • Need a unified system of managing information on state-owned and private lands • Eliminate difficulties for people to visit Divisional Secretariat or LSD, MC, or Land Registry in person to submit civil applications • Resolve the issue where only certain institutions can apply for surveying directly to SDSL (SDSL), while other organizations must apply through the Divisional Secretariat which increases the time and cost required for processing • Eliminate the difficulties in land administration and social costs incurring from the combined use of the deed and title systems; digitize the registered ownership information and continually update the information to improve accuracy • Link the systems used by other entities to lay the groundwork for sharing data • Eliminate inefficiencies resulting from redundant tasks such as uploading data online and preparing and sending documents offline
	Data management	• Eliminate difficulties in searching, retrieving, storing, and managing vast materials in library (substantial increases in documents that need to be managed each year) • Need measures to counter the risks of loss and damage of important data caused by natural disasters such as flood, earthquake, fire, war, etc. • Address the issue where survey maps from the 19th century with considerable historical value are being continually contaminated, etc. due to inadequate management • Eliminate difficulties in expressing and managing various cadastral attributes (buildings, roads, etc.) • Eliminate difficulties in managing information on private lands
Digitization	Digitization	• Most of the cadastral information digitization projects have not been completed (80% of the scan work on the old plan completed) • Eliminate difficulties in linking entities through a network • Eliminate difficulties in scalability and recycling due to the use Windows-based DBMS and servers
Data sharing	Data management	• Reduce work hours spent on data inquiry through data digitization • Establish a unique key system to share and utilize land information (graphs and attributes) on Sri Lanka • Need to secure a unique key assignment system based on title numbers: Korea has 19-digit PNU (Parcel Number Unit), which enables nationwide land information inquiry, management, provision and linkage

Area	Type	Matters Requiring Improvement
	Data utilization	• Create an environment where people can easily recreate and process the land information they desire online • Minimize redundant work and maximize information sharing and utilization by establishing and operating an integrated land information management system at the national level
Information utilization	Information	• Need a system for determining the exact locations of individual lands on the deed, similar to the lot number on title certificates • Need to devise measures to provide information in the form desired by the institution user because land information is used by multiple government departments and institutions • Secure measures to share information on private lands with local authorities (MC)
	Processing	• Create a platform for relevant entities to request, analyze and share data for land information sharing
Organization environment	Organization manpower	• Address the lack of manpower for digitization of national land information even though there exists an IT department that specializes in managing systems and infrastructure • Need professionals with the knowledge of the process of establishing the necessary system for national land information digitization project who can operate and manage such system • Resolve issues concerning the existing professionals failing to adapt to or being disinclined toward digitization
	Division of roles	• Need to obtain land information including information on water supply and sewerage, buildings and facilities on private lands managed by the local authorities (MC) and to establish a plan for managing the data needed by the local authorities (MC) in order to share and utilize the land information at the national level

❍ The core elements and key points that should be considered first in relation to the matters requiring improvement were derived, and based on this, the preliminary tasks and key tasks were defined.

[Table V-2] Preliminary and Key Tasks

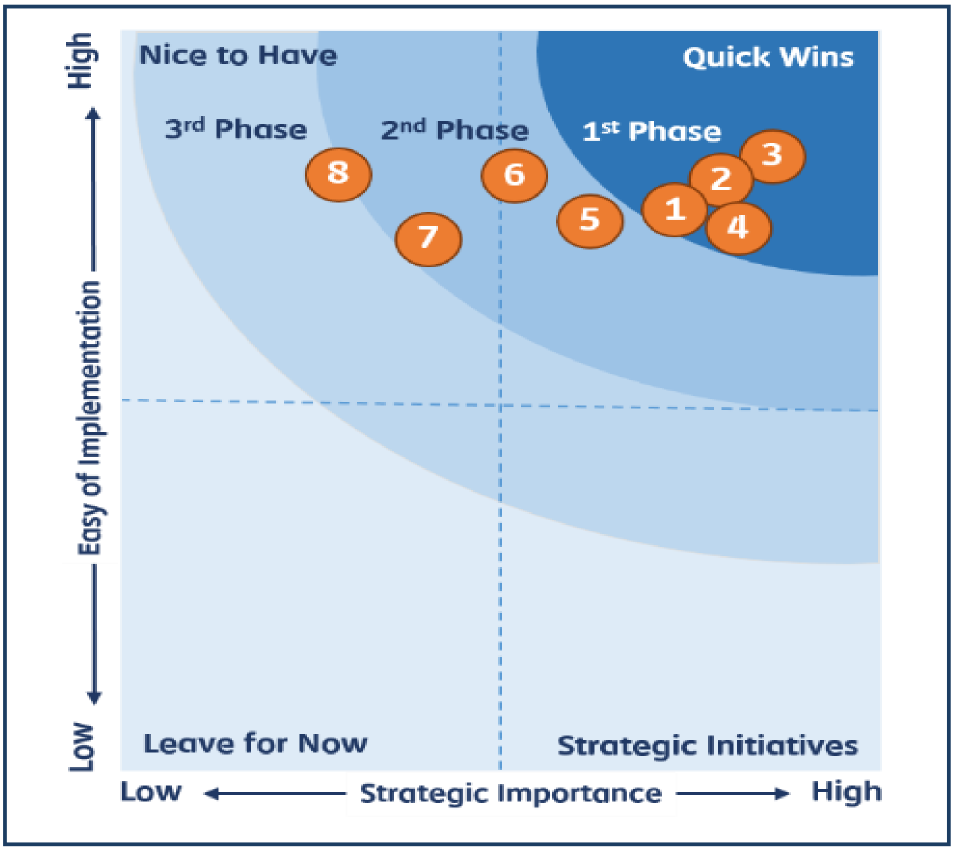
Area	Key elements and focus
Processing procedure and time	• Because the processes are spread across multiple institutions, the time it takes to complete processing is prolonged due to the delays in receiving, authorization, notification processes, etc. Also, notifications are sent manually to each other, and this results in many types of required documents and increased wait time for the following procedure
Parcel-based database setup and management	• In Sri Lanka, it is difficult to apply the unique key system that allows the user to search across the parcels across the whole country together at once. In Korea, the unique key system is applied through the address (lot number) system, but in Sri Lanka, all the parcel information is managed internally in the SDSL based on the application number. Ultimately, a separate (temporary) item must be established to apply the unique key, but it will difficult to raise public awareness of the new system. Therefore, it is essential to prepare a unique key system that utilizes the current title numbering system.
Real-time information update and sharing	• From the policy aspect, there is a need for an information update system that can accept requests from information users (institutions) and provide the requested information as quickly as possible so that the information generated by each agency can be used by other government departments.
Organization, capacity building and training	• As for the organizational environment, professional manpower is important for ongoing maintenance of the new systems and infrastructure. There is a need to establish a general management organization for sharing and using land information at the national level.

Preliminary and Key Tasks	
Preliminary tasks	Key tasks
• Construction of GIS-based cadastral and surveying information management system • Construction land administration system for land administration support • Construction an Internet-based cadastral administrative service system • Development of system for linking institutions that need to share land information • Need cadastral database modeling that reflects the Sri Lankan environment • Strengthen manpower training program that enables system maintenance rather than training manpower for setting up the database	• Digitize national land data • Provide land administration support and construction information service system for public • Strengthen national land management capacity • Construction national land information integration and linking system • Establish a land information system and policy support plan • Data standardization • Construction integrated land management system with single channel • Sustainable update and management system for integrated DB

1.3. Priority Selection

❍ The order of priority among the key tasks for achieving “Land information value innovation through a land information management system,” which is the future vision of Sri Lanka land information system, was selected based on the strategic importance of each task and the ease of its implementation. The priority portfolio for the 8 key tasks is as follows:

① Digitalization of national land data
② Provide land administration support and construction information service system for public
③ Strengthen national land management capacity
④ Construction national land information integration and linking system
⑤ Establish a land information system and policy support plan
⑥ Data standardization
⑦ Construction integrated land management system with single channel
⑧ Sustainable update and management system for integrated DB



[Figure Ⅴ-3] Priority Portfolio of Key Tasks

2. To-Be Model of the Target Project

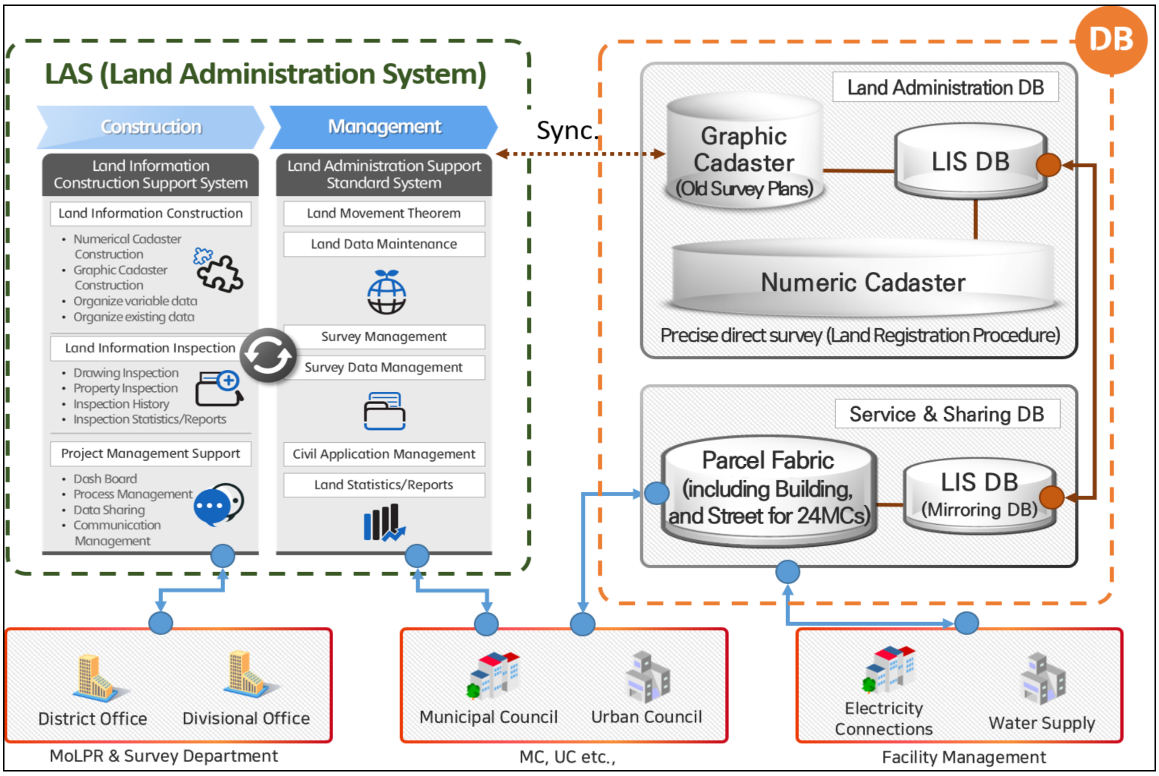
2.1. Overview

❍ The land information system (LIS) of Sri Lanka is divided into two sectors: 1) land information data and 2) the system for land information management and utilization.

❍ Data sector are parcel data obtained by digitizing the existing Survey Plans and spatial data on parcels, buildings, and streets for major municipal councils. This sector also includes CORS Network installation and high-resolution satellite orthoimage production so that data can be built seamlessly.

❍ The system sector consists of the systematizing the work processes in the land information production and management process, the administrative system that uses land information, and the land information service system that allows sharing of land information with related entities.

❍ The To-Be Model for the data and system sectors of the LIS which is to be established through this project is as follows:



[Figure Ⅴ-4] To-Be Model for the LIS

❍ The To-Be Model for the Sri Lanka's LIS requires not only an organic relationship between the data sector and the system sector, but also operating infrastructure to meet the requirements in relation to the data center and system functions for smooth system operation and services.

- Also, the system should be kept current by continuously updating data, and for this purpose, the necessary survey and geospatial database construction infrastructure must be in place and the requirements for data construction, system operating organization, and the capacity of organization members must be met.

- Therefore, in order to achieve the To-Be Model for the Sri Lanka LIS, there must be a balance across the data sector, the system sector, the operating infrastructure sector, and the capacity building of the operating organization and its members.

[Figure Ⅴ-5] Infrastructure of the LIS

2.2.To-Be Model for Land and Spatial Information DB

- The parcel data of the Sri Lanka LIS consists of graphic cadaster[26] derived using old survey plans and graphic cadaster extracted from 5cm UAV aerial orthoimages. They are updated as numeric cadaster[27] through the land registration procedure.

- Also, in order to express the parcel data on the graphic cadaster, a database of image base maps composed of 50cm satellite orthoimages and 5cm UAV aerial orthoimages should be built to maximize the utility of the graphic cadaster.

[26] Graphic Cadaster: Land information where parcel boundaries based on the current status of land are graphically expressed in various methods other than precise direct surve

[27] Numeric Cadaster: Land information where land boundaries are set by precise direct survey and the results in relation thereto are confirme

❍ In order to raise the efficiency of administrative work by improving the land registration rate, applying a system for the relevant entities to share and update the current parcel information, and using street and building information, the to-be model shall be as follows:

[Figure Ⅴ-6] To-Be Model for Land and Spatial Information DB

- The To-Be Model for the database is largely composed of the background map area, the graphic cadaster area, the spatial database area of parcel, building and streets, and the attribute information (parcel, building, and street) area.

- First, the background map area uses 50cm satellite orthoimages as the primary image background map for the entire Sri Lanka and combines 5cm aerial orthoimages for 24 major municipal councils to be used as the secondary image background map.

- The image background map is reprocessed as a tiling structure to ensure ease of management and service. The tiling structure is to prevent the slowdown caused by image queries such as image enlargement, size reduction, and movement, etc. made by multiple users.

- Second, the graphic cadaster area is set up so as to digitize the old survey plans that are stored and managed by the district survey offices operating under SDSL in the form of drawings and assign coordinates from the real world in order to provide the parcel boundary information according to the land status as graphical representations. The graphic cadaster is also created in a vector format by extracting the parcel boundaries according to the current status of land using 5cm aerial orthoimages for 24 major municipal councils and reprocessing them into cadastral information through a polygonization process.

- Third, the area concerning geospatial information on parcels, buildings and streets is set up by extracting parcel boundaries, building boundaries and street boundaries from 5cm aerial orthoimages for 24 major municipal councils and constructing the spatial objects of parcels, buildings and streets in the vector format through a polygonization process.

- Lastly, the attribute information in regard to each parcel, building, and street is examined and entered, and through the process of structured editing in which the information is combined with spatial objects, a spatial database of the parcels, buildings and streets each is set up.

- The primary spatial database is updated in the form of a numeric cadaster where land survey performances are confirmed through the land registration process of the land administration system. Also, CORS-Network is set up in order to enable Virtual Reference Station (VRS) service throughout Sri Lanka for the purpose of maximizing the efficiency of land survey work.

- The aim is to install CORS-Network at 32 locations in other regions aside from Western Province.

- In addition, survey equipment will be provided for Sri Lanka to continuously update its land data and spatial database on its own so that the land information system can be kept current.

2.3.To-Be Model for the LIS

2.3.1.Objectives of System Development

- The government of Sri Lanka aims to manage title registration through the Bim Saviya program.

- SDSL, which is in charge of collecting and producing cadastral information in Sri Lanka, is conducting land surveying and digitization through the Bim Saviya Program, a land ownership registration program. However, the registration rate is low, and there are problems of illegal land occupation and inadequate taxation due to unregistered lands.

- Accordingly, it has been noted that it is necessary to establish a unified and standardized land information system to link the land data of government departments and meet the needs for public services concerning land-related affairs.

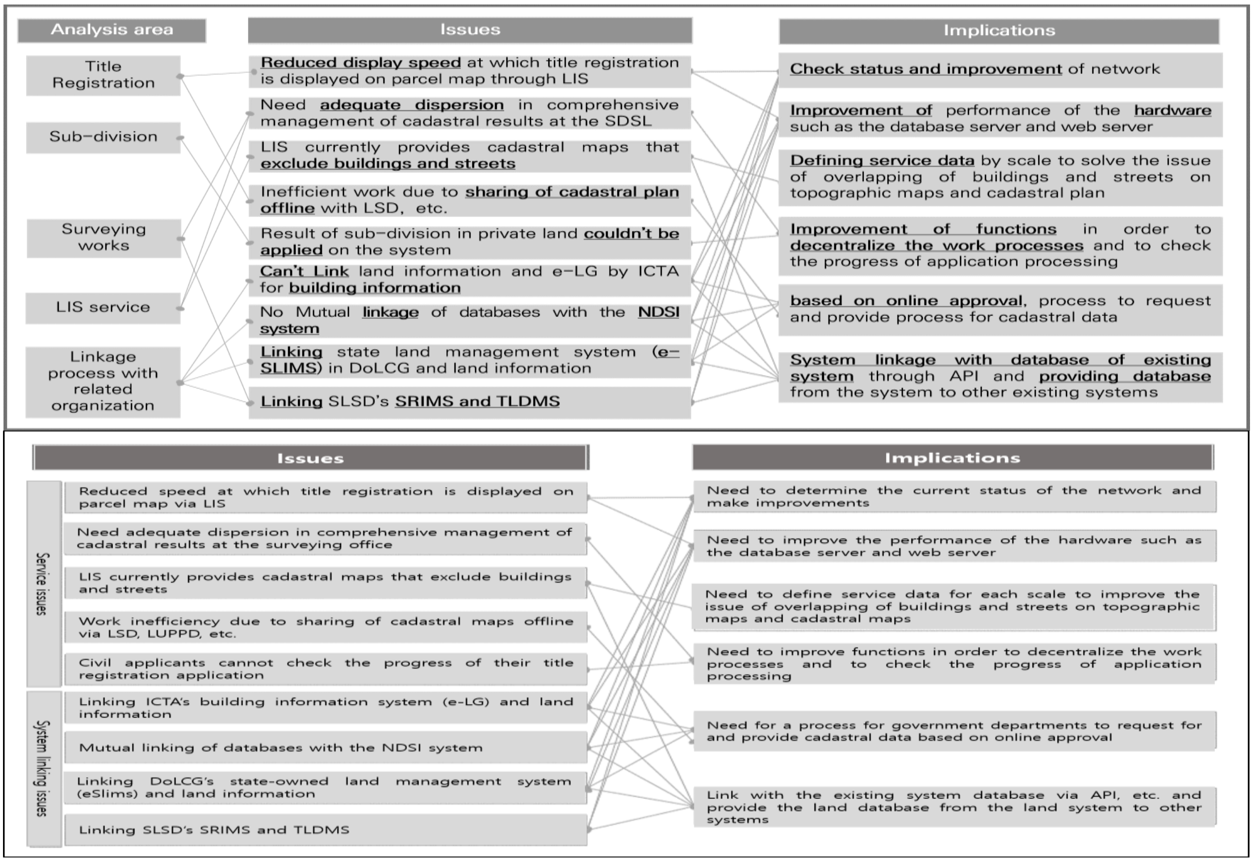
- In the case of Sri Lanka's land information system, work concerning title registration, land division, etc. should be digitized and such should be linked and used by government departments concerned in land affairs through a computer network. Digitization of land-related processes must be performed in the direction that serves to improve public services for land-related civil applications.

- Spatial information technology should be introduced so as to pave the foundation to develop it into a decision-making system that can be used in urban planning and policy by superimposing and analyzing cadastral maps, streets, buildings, and satellite images, and the goals of system development are as follows:
  - To establish a land administration system for the purpose of strengthening the government's land administration capacity to protect the people's rights to land, improve land information services, resolve related disputes, etc., enhancing transparency and equity, and boosting revenue from land.
  - To establish a land information service system that promptly provides land information and improve public services for civil applications
  - To build a system for preparing cadastral surveying results based on the use of UAV and T/S and managing surveying history
  - To build a system that can manage high-resolution UAV orthoimages and superimpose them with cadastral map
  - To build a system for the Land Settlement Department (LSD), Department of Land Commissioner General's (DoLCG), Department of Registrar General's (DoRG), Survey department of Sri Lanka (SDSL), and Land Reform Commission (LRC) to link their cadastral maps and use them jointly together.

2.3.2.Definition of the To-Be Model

1) Current Status of Land-Related Processes in Sri Lanka

- Land-related tasks such as title registration and land subdivision work performed by SLSD, LSD, DoLCG, DoRG, Municipal Council, etc. in Sri Lanka were analyzed based on the current laws, systems, and interviews with the persons in charge. Through this, it was found that setting up an automated processing system and information sharing system, utilizing integrated information, and improving the supporting infrastructure are necessary.



[Figure Ⅴ-7] Implications of Land-Related Processes

2) Direction of the Land Information Service Model

❍ In terms of updating Sri Lanka's land data, there are issues with respect to whether the data are kept up-to-date because the system, in which the spatial and attribute information is updated after the surveying results are obtained from the field, is not supported by adequate software and thus it takes a long time for the data to be updated. Also, there is a need to improve the administrative services, due to the absence of a service system that can inform civil applicants the status of their application (progress of processing).

❍ In the survey aspect, the plan is to introduce a field surveying support system and a surveying inspection system to drastically improve the accuracy and process of surveying and to make improvements based on civil complaints by introducing a system of delivering information to civil applicants so as to enhance the quality of land-related administrative services.

[Table Ⅴ-5] Expected Impacts of Land-Related Improvements

Category	AS-IS	TO-BE
Surveying	• Difficult to check surveying results in real time on site • Excessive workload because surveying results are prepared using AutoCAD • Absence of a system to systematically manage surveying results • Visual inspection of most of the survey results	• On-site real-time checking of the surveying data as they are acquired thanks to the on-site surveying support system • Fast production of accurate surveying maps based on the surveying results preparation system • Automatic inspection of surveying results based on the surveying performance inspection system
Title registration	• There is no completion status delivery system in DSO after DSO completes surveying in Bim Saviya area in preparation for title registration. • LSD visits the block in the Bim Saviya area to complete the survey; there isn't a system for delivering information to the civil applicant for title registration after the surveying is completed	• When DSO registers surveying results in the Bim Saviya area on LAS, LSD is automatically notified to reduce waiting time. • When the preparation for title registration is completed, the information is provided to the applicant via SMS, etc.
Sub-division of land	• In the case of sub-dividing a private land in a cadaster area, the final approval must be obtained from the MC and no information is automatically reflected in the cadastral map • In the case of sub-dividing state-owned land located within a cadaster area, a Divisional Secretariat surveying is requested and the results are received but there is no system for automatically reflecting the results in the cadastral map	• When the MC approves of the application for subdivision, it is automatically reflected in the cadastral map, so that it is always kept up to date • By LAS, Results of sub-dividing state land are automatically registered after from the Divisional Secretariat

❍ There is no proper information linking system between entities responsible for land-related tasks in Sri Lanka, making it impossible for information to be delivered in a timely manner and delays and wait time are inevitable.

❍ The plan is to set up a system that can improve work productivity by eliminating wait time and delays through the introduction of an information sharing system for entities performing land-related tasks. In addition, the latest land information can be searched and retrieved and various statistical information is visualized in the form of tables, thematic maps, etc. so that it can be practically utilized for land policy decision-making processes.

[Table Ⅴ-6] Direction of Improvement for Tasks Performed by Land-Related Entities

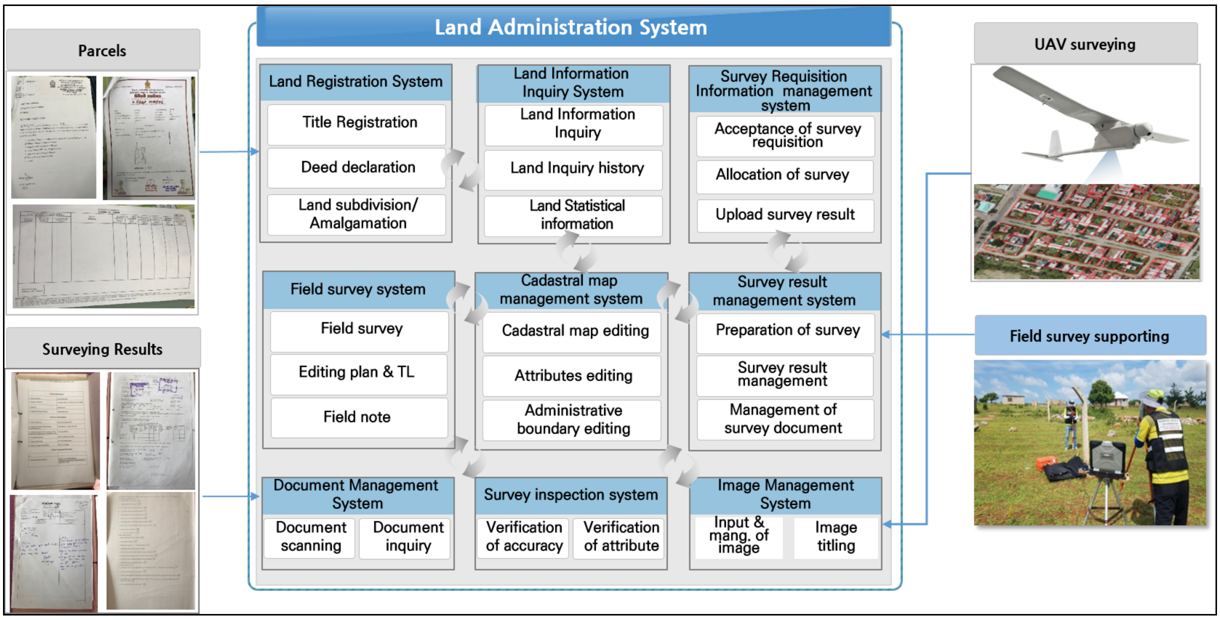
Category	AS-IS	TO-BE
SDSL	• Delays caused by collective updates of cadastral maps within cadaster areas by SDSL • Poor surveying productivity due to a lack of a system for surveying data acquisition, results preparation, and results inspection • Provide only cadastral maps that do not include buildings and streets • Visual inspection of most of the survey results	• Eliminate delays by distributing cadastral map updates across regions using the system • Improve surveying accuracy and productivity by introducing field surveying support system (TOSS) and surveying results preparation and inspection system • Bolster the prestige a cadastral and spatial information agency by providing multi-purpose cadastral maps that contain information on buildings, streets, and land use
DoRG	• Currently, it often takes more than 50 seconds to check a parcel map via LSD, attesting to the inefficiency of the public services • There is no system for online delivery to LSD when a title certificate is produced for the first time	• Improvement of public service by Improving public services by boosting the parcel map checking speed with a better system server and network • Speed up processing speed by sharing information online with related organizations such as LSD, SDSL
LSD	• Inefficient because cadastral maps in Bim Saviya are provided offline • Lack of delivery system for sharing information with relevant entities at various stages of the Bim Saviya program	• Boost work efficiency by receiving cadastral maps online via the LAS • Increase productivity by reducing waiting time through the sharing of information on the progress of each step of the Bim Saviya program in real time
DoLCG	• Lack of a practical system for selecting targets for land alienation	• Transparent selection of beneficiaries of land alienation through the system
MC	• In the case of land sub-division, final approval is by MC, and information is not automatically reflected on the cadastral plan. • The assessment number is not entered in the cadastral map, so the land valuation information of the parcel cannot be linked	• After land sub-division approval, the system automatically reflects the cadastral plan to always use the latest cadastral plan for work. • Land valuation information can be used in the system by inputting the assessment number managed by MC

3) To-Be Model for the LIS

❍ The To-Be Model for the Sri Lanka LIS was defined by classifying the functions for development derived through the analyses of land-related tasks in Sri Lanka and current status of the existing system as well as a comparative analysis of the LIS and the Korea Real Estate. Administration Intelligence System (KRAS).

❍ The scope of this project phase largely consists of two systems: the Land Administration System (LAS) and the Land Information Service System (LISS).

❍ Land Administration System (LAS)



[Figure Ⅴ-8] To-Be Model for the LAS

– Land registration system: Register title, register and edit land information such as land subdivision and merger, scan and store related documents, and issue title certificates to civil applicants

– Cadastral map management system: Perform cadastral partition and merger and create topology on new cadaster and linking it with parcel information to manage it as cadastral maps

– Document management system: Scan, register and display land-related documents, surveying results, and field notes

– Land information inquiry system: Search registered cadastral information, search past history data for various administrative tasks, and link cadastral statistical information for each administrative district with spatial data to be expressed on various thematic maps so that it can be easily understood and used

– Surveying requisition information management system: Receive applications for surveying by civil applicants and institutions and assign surveying tasks to surveying technicians (surveyors)

– Surveying results management system: A system for preparing cadastral survey results using UAV and T/S by performing calculations, saving results, and creating drawings (maps) and reports

– Surveying results inspection system: A system for inspecting cadastral surveying results by verifying attributes, graphs and files, correcting attribute errors, checking overlapping and printing the survey plans

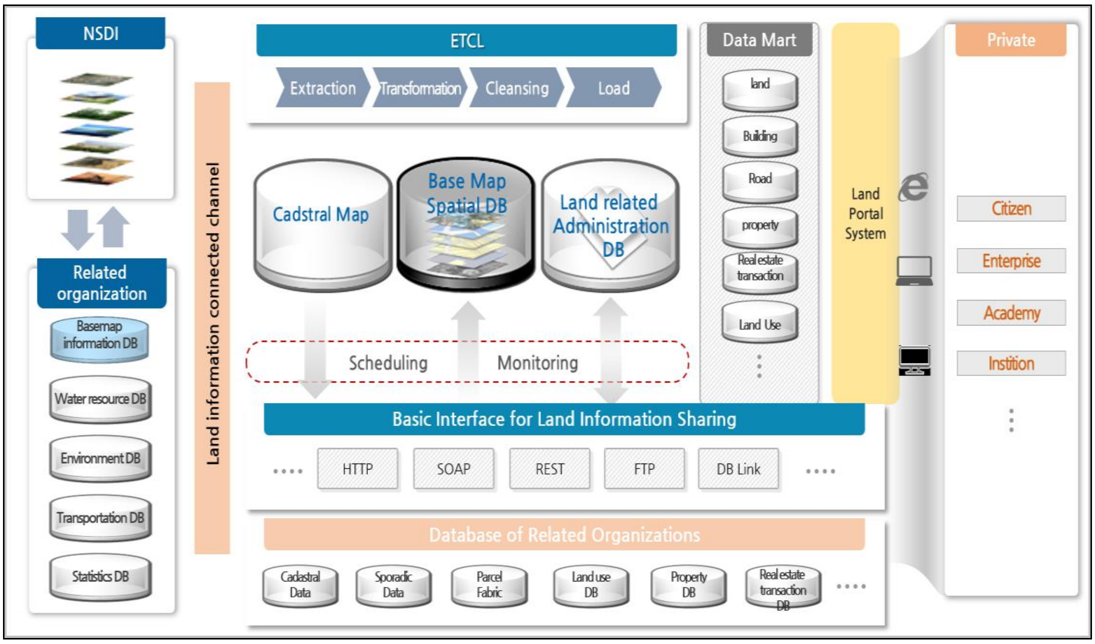
– Field surveying system: Consists of field surveying support functions with the application of new technology to obtain cadastral data more easily and quickly in the field

– Image Basemap Management System: Management of output from UAV survey and satellite image

❍ Land Information Service System

– Set up a convenient service allowing ordinary citizens to superimpose satellite images and aerial photographs to check cadastral map information and information on state-owned land, private land, etc. on the Internet

– Allow civil applicants to check their application status anytime, anywhere via the Internet



[Figure Ⅴ-9] To-Be Model for the LISS

2.4. To-Be Model for Data Center and Infrastructure

2.4.1. To-Be Model for the Data Centers

❍ As for the data centers and operation infrastructure for Sri Lanka's land information system, the main data center will be established at the IT branch on the Second(2nd) Floor of the SDSL headquarters where the facilities of the existing land information system (LIS) are in operation. Also, a backup data center will be set up using the space of SLT IDC (Tier-III certified), and business continuity will be ensured and an environment for disaster recovery will be created through the operation of a hot site (identical configuration, real time synchronization) between the data centers.

1) Basic design direction for the data centers and operating infrastructure

❍ Formulate a system optimization plan in consideration of the current status and overall matters

❍ Secure stability, scalability and security in consideration of land data services targeting the public and the government

❍ Design the main equipment and data to be in high availability

❍ Set them up as a flexible and standardized system considering the connection with related entities and external entities

2) Conceptual design

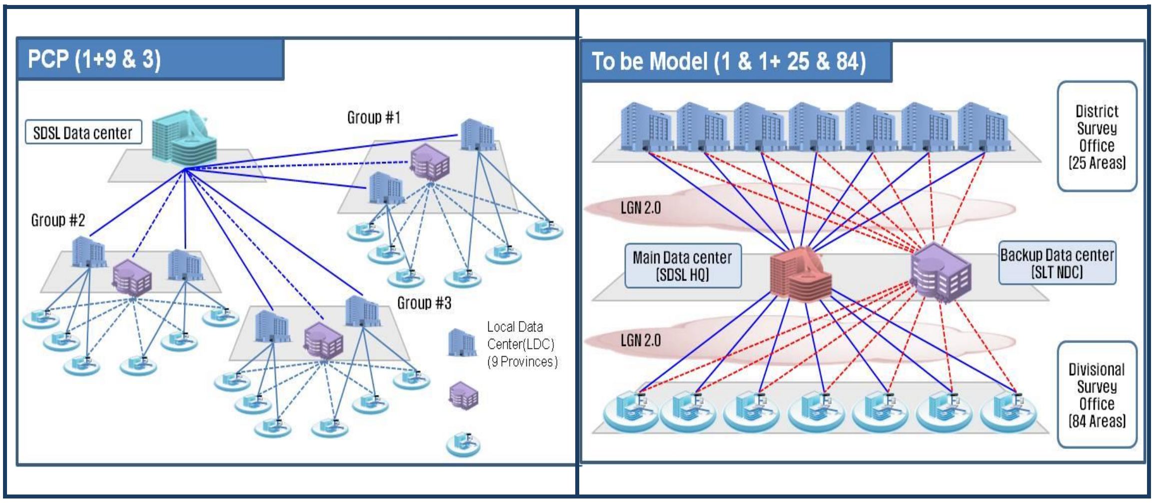
❍ Project concept paper (PCP) requirements

– Data Center: 1 location

– Local Center: 9 locations
– Local Backup Center: 3 locations

❍ F/S to-be model

– Main Data Center: 1 location
– Backup Center with the same function: 1 location
– Network environment and facility improvement: 25 locations (District Survey Office)
– Network environment: LGN 2.0 application: 84 locations (Divisional Survey Office)



[Figure Ⅴ-10] PCP vs To-Be Model

❍ Reason for change

– Candidates of the Local Data Center are nine provincial offices of the surveying office. Only the director's office and the administrative office are located.(IT Brach in SDSL is deployed / operated only by the main office)

– It was difficult to secure the floor area and additional facilities necessary for the construction of a new server room or local center because only the resident personnel had been taken into consideration when designing the space.

– Plus, Province Office was not included in Data Flow-Chart currently. So that, it might be possible to be a bottleneck effect potentially, if nine local data centers were to be added to the data flow related to storing, transmitting and using surveying data.

– Stable power supply is not secured except in the Western region where the capital, Colombo, is located. As a result, most Provincial Offices cannot use A / C in the office space

– The government network entered the stabilization phase with the project coming into completion in 2017. Therefore, it is expected that the cost of managing and operating the network used by the main office and the local offices will be lowered.

– Therefore, in case normal availability cannot be ensured in the event of a natural disaster, fire, etc. after setting up a centralized data center, a backup center that can function like the main data center should be added, and the efficiency and effectiveness of the work carried out at the local offices should be promoted by improving the network environment and supplying workstation-level equipment.

[Table V-7] Comparison between PCP vs To Be Model

Category	PCP	To Be Model
Pros	Highest accessibility of the lowest regional offices because data can be collected / transmitted through LDC. Securing business continuity by using regional center and backup center in case of MDC failure. Easy to share regional data in groups. Reduction of network construction cost when building own network.	Provide access to the same conditions / data for each regional office. DR can be configured by synchronizing between MDC and Backup Center. Reduced deployment and operating costs compared to distributed center methods Minimize business interruption when providing public / government services
Cons	Increased initial and maintenance costs. Require adequate staff for management. Update delay due to synchronization process between LDC, MDC, and Backup Center. Low access to other regional data. Public / government services are provided only by MDC, so there is no response to MDC disability.	Excessive cost in establishing link between central and regional offices when building self-managed networks. It is necessary to estimate the bandwidth considering peak time due to access from individual regional offices. Central system access is also required for DB access to local and neighboring areas.
Reason for selection	The centralized data center plan was decided as 'To be Model' for the following reasons - Sri Lanka's LGN 2.0 uses SLT network to provide government network services to individual regional offices and MDC target survey offices - The work process of the surveying DB management system in use is settled centrally. - It is difficult to secure proper environmental infrastructure (including network) and management personnel in regions other than Western Province. - In order to provide LAS and LISS, it is inevitable to concentrate facilities and systems in the main data center. Therefore, the regional center plays only the role of data gathering, so the investment cost is low.	

3) To-be model for the infrastructure for operating data centers

❍ The to-be model for the operating infrastructure was designed in consideration of security, s tability and scalability

❍ Security

– Apply DDoS (Distributed Denial of Service), IPS (Intrusion Prevention System), firewall, and access control system to prevent distributed service attack and intrusion, detect and block malware, etc.

– Install an additional firewall in the Server Zone to protect important data from unauthorized intrusion or hacking

– Set up Web/WAS servers for public/government services in the DMZ Zone and install a web firewall in the front to prevent attacks on the web service

❍ Stability

– Design the redundant configuration for major Systems and Modules

– Introduce a backup solution to keep important data safe
– Design redundant UPS design suitable for the system capacity (e.g. servers and network) in case of power failure
– Ensure efficiency and stability of the security system by applying an integrated management solution for the security facilities
– Apply NMS (Network Management System), SMS (Server Management System) and FMS (Facility Management System) to manage the network, server system, UPS, thermo-hygrostat, etc. in a stable manner

❍ Scalability

– Secure extra space (30% extra space) in the equipment room of the main data center to facilitate expansion of the facility in the future and accommodate facility expansion in the power supply, HVAC(Heating, Ventilation, Air Conditioning) equipment and cable tray designs
– Apply standardized technology for connection and information-sharing with external entities

4) Details of the ICT infrastructure setup for data centers

[Table Ⅴ-8] Details of ICT Infrastructure Setup

Category	Description
Space plan	Rack composition and facility layout
Power equipment	Power feeder line (redundancy), UPS, and batteries
A/C and firefighting equipment	Thermo-hygrostat, firefighting equipment, and fire extinguishing medium
Security facilities	Access control system and CCTV
Network	Network infrastructure, security equipment, security software and backup
Interior	Raised Floor, flooring, ceiling, lighting and wall construction for each room, etc.

❍ The design standards for the data centers follows the international data center infrastructure standards (TIA-942 Data Center Standards Overview), based on local conditions:

[Table Ⅴ-9] List for Data Center Grade

	Tier Ⅰ	Tier Ⅱ	Tier Ⅲ	Tier Ⅳ	MDC (Target)	BDC
Data center availability	99.67%	99.75%	99.98%	100.00%	99.67%	99.98%
Annual failure time	28.8	22	1.6	0.4	1.6	1.6
Redundant power and cooling facilities	N	N+1	N+1 (Dual Op.)	2(N+1) or S+S	N+1	2(N+1)
Operational Room	N/A	N/A	Required	Required	Yes	Yes
Security (From Lobby to Server Room)	General Lock Devices	Card Reader	Biometric Reader	Biometric Reader	Biometric Reader	Biometric Reader
Redundant Back Bone	N/A	N/A	Required	Required	Yes	Yes

	Tier Ⅰ	Tier Ⅱ	TierⅢ	TierⅣ	MDC (Target)	BDC
Redundant Router and Switch	No	No	Yes	Yes	Yes	Yes
Redundant Access	No	No	Yes	Yes	No	Yes
Secondly Access Control	No	Yes	Yes	Yes	No	Yes
Support for Rack/Cabinet	No	Flooring Support	Pole Support	Pole Support	Flooring Support	Pole Support

[Table V-10] ICT Infrastructure Design Standards

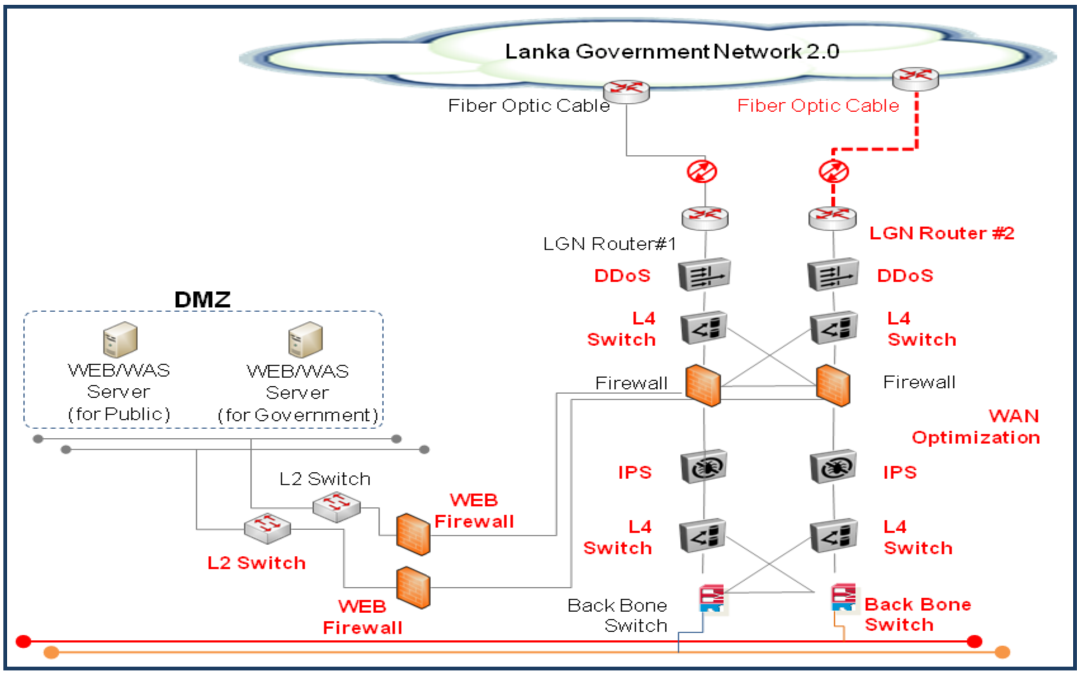
Category	Main Data Center	Backup Data Center	Remarks
Telecommunication	Tier -3 (T3)	Tier - 3 (T3)	Redundant incoming network and major network facilities
Electrical	Tier - 1 (E1)	Tier - 3 (E3)	Limited application due the use of existing buildings instead of an IDC-specific space (Main Data Center)
Architectural	Tier - 1 (A1)	Tier - 3 (A3)	
Mechanical	Tier - 1 (M1)	Tier - 3 (M3)	

2.4.2.To-Be Model for the Local Offices

1) Network Redundancy and Bandwidth Expansion

- Form redundancy by connecting new optical cables from separate nodes
- Make sure that the routers, backbone switches, L2 switches for the main equipment, and se curity equipment are configured to accommodate redundant optic cables and prevent equipm ent failure due to disuse and reduce the transfer time during emergencies by load balancing
- Expand external connection bandwidth of the new data center to 50Mbps (LGII)[28]

28 LGII: Lanka Government Information Infrastructur



[Figure Ⅴ-11] Data Center Network Construction Plan

2) District Surveying Offices

- ❍ There are two to five district survey offices in each province for a total of 25 district survey offices across the country.
- ❍ Currently, networks leased from LGN 2.0 and Sri-Lanka Telecom are both being used, but the network used by each office is different.
- ❍ The LGN bandwidth of each office set by LGII is 2Mbps but will be expanded to 10Mbps in the future.
- ❍ Work efficiency will be enhanced by improving the wireless network currently used by only some of the users to a wired intranet and replacing old PCs used for surveying work with workstation-level PCs.

3) Divisional Surveying Offices

- ❍ Divisional surveying offices operating under the district survey office are the ones that actually perform the surveying work and create and upload surveying drawings. There are one to six divisional surveying offices per district surveying office for a total of 84 divisional surveying offices across the country.
- ❍ At present, only the network leased from Sri-Lanka Telecom is being used, but LGN 2.0 supplied by LGII will be applied for integrated management and cost reduction purposes (additional consultation necessary upon changing PCP requirements).
- ❍ Routers, firewalls, switches, and housing racks with the same specifications as the existing equipment at district surveying offices will be introduced to be linked with LGN 2.0.

2.4.3.Local Authority environment improvement To Be Model

- Providing a LAS User PC(including LAS Client Software) to improve the accessibility of each MC for the LAS and LISS to be introduced through this project
- Provides two LAS User PCs for each MC.
- O & M is included in the scope of the project during the project period (construction and maintenance support period), but is managed as the responsibility of each local authority for subsequent periods.

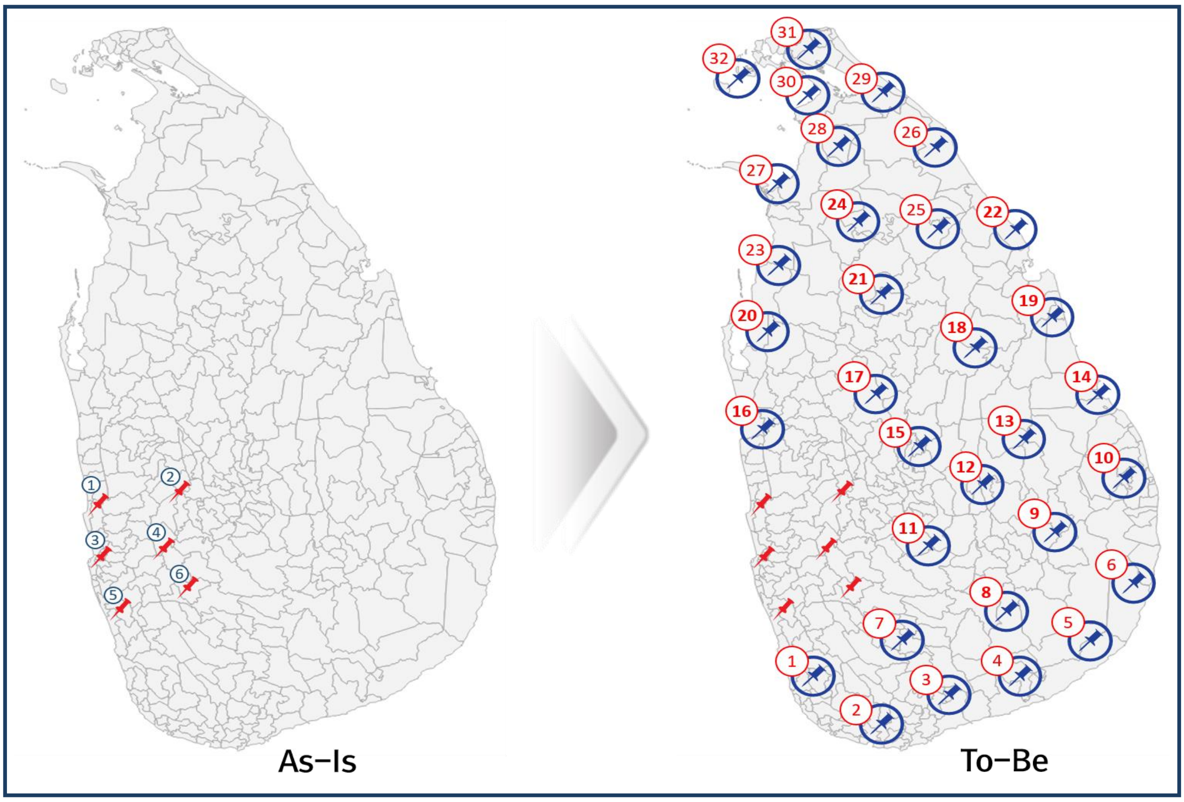
3. Implementation Plans for Land and Spatial Information DB

3.1.Overview

- The objectives of the project concerning the land and spatial information DB for the establishment of the LIS are largely divided into four topics, which are interrelated with each other.
- The first topic is the nationwide installation of the CORS Network, which is currently being operated on a pilot basis solely in Western Province.
- The second topic is the production and supply of 50cm high resolution satellite orthoimages as background maps for digitizing existing Survey Plans based on a unified coordinate system (SLD99).
- The third topic is the digitization of existing Survey Plans based on 50cm satellite orthoimages and generation of spatial data for each parcel.
- The fourth topic is the implementation of UAV aerial photogrammetry on the areas under the jurisdiction of 24 major MCs to produce 5cm UAV aerial orthoimages, and build a spatial database for parcels, streets, and buildings based on the orthoimages.

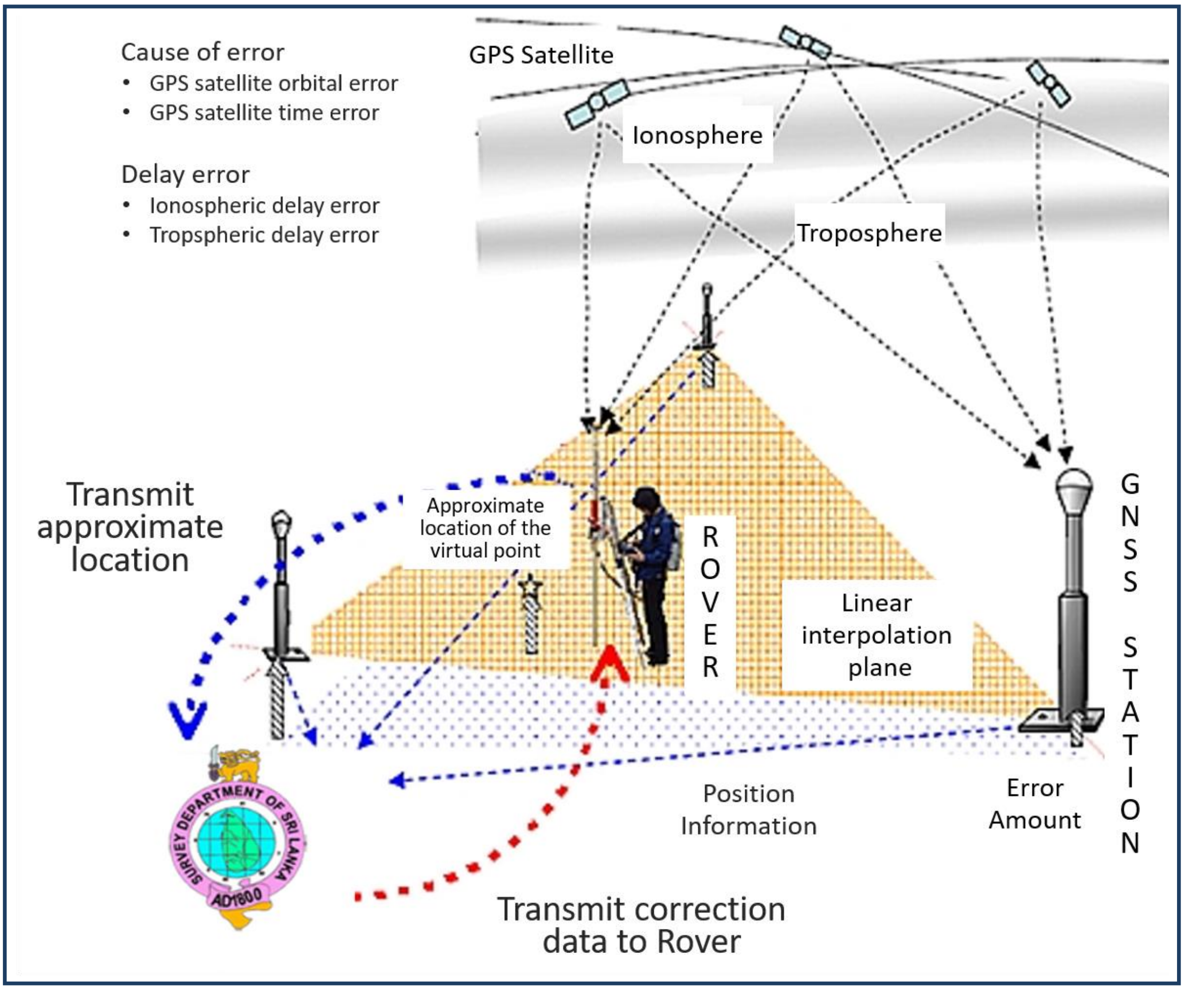
3.2.Additional Installations of CORS

- 32 additional GNSS stations will be set up in addition to the 6 GNSS stations currently in operation in Western Province for VRS services across Sri Lanka.
- The additional GNSS stations will be set up so that a triangulation network among the nearby stations can be constructed and the distance of the baseline of the triangulation network does not exceed 100km.
- In order to ensure that even the southern and northern islands can receive seamless VRS services, the distance of the baselines in the area will not exceed 60km. Based on this, it was decided to install 32 additional GNSS stations to provide VRS services throughout Sri Lanka including the island regions.



[Figure Ⅴ-12] CORS-Network As-Is To-Be

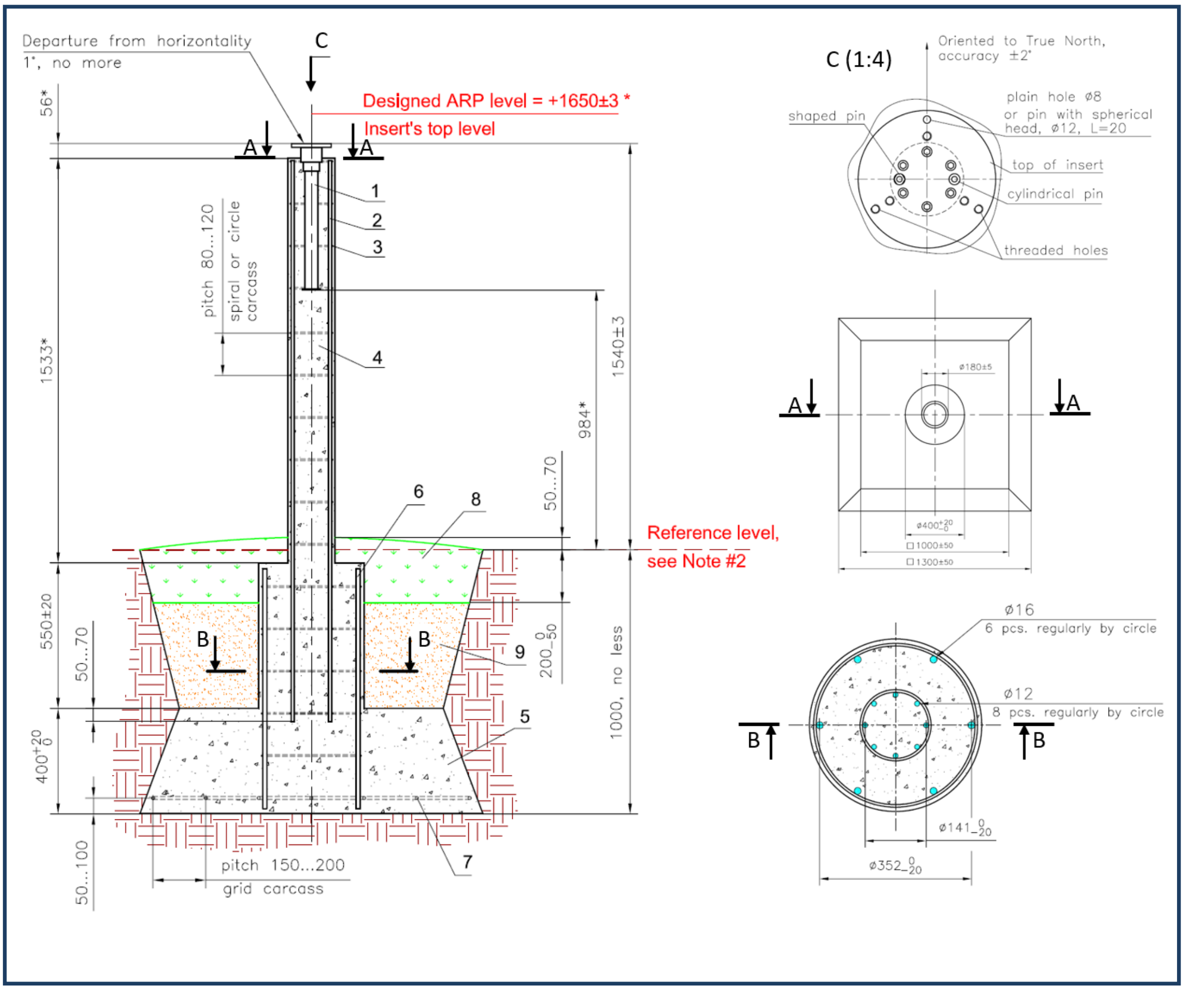
❍ In the case of VRS services, the distance between the reference stations constituting the mu lti reference networks should not exceed 100km because the data in relation to the rover sta tions are corrected through the multi reference networks (however, in the case of islands, th e rover station may not be included in the triangulation network of the CORS Network, and thus the distance between the baseline and the CORS Network should be within 60km in s uch areas).



[Figure Ⅴ-13] VRS Principles

❍ 32 additional GNSS stations should be installed in the district survey offices operating under the SDSL in consideration of the ease of power supply and stability of management. However, if there isn’t a district survey office in the installation area, the station should be installed at a public institution in cooperation with the institution in question.

❍ For every GNSS station, a stainless or concrete pillar must be erected on top of a solid foundation concrete measuring at least 1m in height. It should be equipped with a device that can be leveled on top of the column and a GNSS antenna should be mounted on the device.



[Figure Ⅴ-14] GNSS Station Foundation and Pillar Standards

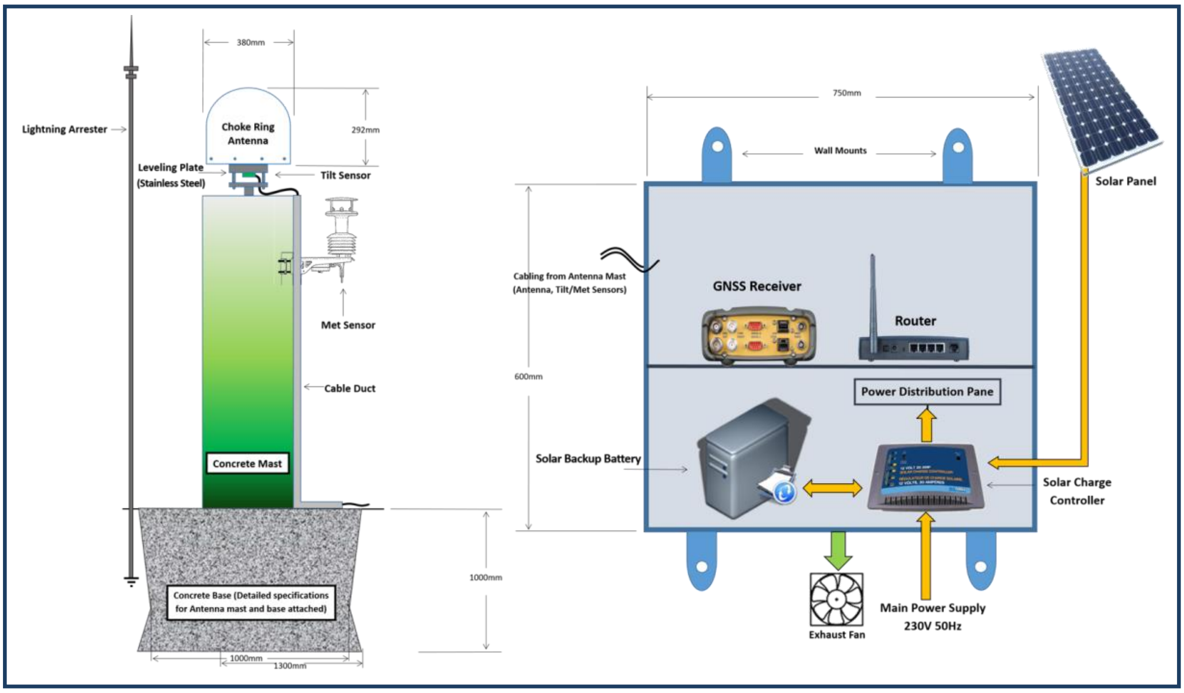
❍ As for the GNSS data transmitted via the GNSS antenna, it must be able to receive GPS (L1, L2, etc.), GLONASS (L1, L2, etc.) and Galileo signals and data from at least 50 navigation satellites.

❍ In addition, it must have features for maintaining data security and security of the communication equipment used in transmitting real-time GNSS raw data from the GNSS station to the Control Center.

❍ The GNSS equipment installed must be compatible with the service system of the Control Center currently in operation, and the equipment installed at each GNSS station must be equipped with uninterrupted power supply (UPS) and the necessary function to protect the GNSS equipment and communication equipment from thunder and lightning.

❍ Highly precise coordinates of the additionally installed GNSS stations should be determined, based on which a test operation should be carried out for at least 3 months in order to confirm the coordinates and guarantee the accuracy according to Network-RTK such as VRS.

❍ The Control Center currently in operation has software for allowing simultaneous connection of 100 GNSS stations and 500 users. Additional hardware including backup equipment as well as software upgrades will be introduced for increased stability.



[Figure Ⅴ-15] Conceptual Diagram of GNSS Station Equipment

- In addition to the software upgrade, development and sophistication of additional functions t o enhance the user interface for improved convenience and post-processing functions of the VRS service will be carried out in parallel.

- GNSS survey equipment for rover stations that can receive network-RTK services will be p rovided, in addition to the installations of 32 additional GNSS stations and the hardware an d software upgrades at the Control Center, so that they can be used in land survey by the d istrict survey office operating under SDSL.

- The minimum requirements for additional CORS installations are as follows:

[Table Ⅴ-12] Minimum Requirements for Additional CORS Installation

No	Item	Specification Requirement
1.0		GNSS Antenna
1.1	1.1 GNSS Antenna	CHOKE RING Antenna with smooth minimal ripple wideband element to allow tracking of all current and planned signals. Antenna should be designed to mitigate multipath and ability to track low elevation satellites. Antenna & monument should be coupled by orienting / leveling device Lightning arrester of suitable type to be installed to protect antenna and GNSS receiver The station’s GNSS antenna absolute calibration should be available. GNSS Antenna Calibration certificate is acceptable from NGS All other available features should be specified in detail
1.2	GNSS Antenna / Meteorological Sensor	Metrological sensor to measure temperature, pressure and humidity sending metrological data to the Control Center. Meteorological Sensor to be quoted as specified in Addenda 1 & 2 with the

No	Item	Specification Requirement
		accuracies of Temperature measurement: ±1℃, pressure measurement: ±0.5hPa and Relative Humidity measurements: ±2% Price of this item should be quoted separately if it is not a standard item of the GNSS Antenna.
1.3	GNSS Antenna/ Tilt Sensor	Tilt sensor to monitor the tilt and connected to GNSS sensor to send tilt data automatically to the central control station The Tilt Sensor of GNSS Antenna is expected to detect the minimum 10mm movements of antenna. Prices of this item should be quoted separately, if it is not a standard item of the GNSS Antenna
2.0	GNSS Receiver	
2.1	Tracking Capabilities	GPS(L1 & L2 including L2C, L5) GLONASS(L1 & L2 including L2c), Galileo (E1/E5a/E5b/AltBOC), Compass (B1,B2,B3) signals No. of satellites (50 satellites and their appropriate signals) No. of Channels – 200 Any other currently available systems and future expansions to be specified
2.2	Initialization	Should be < 60sec, Last settings should be resumed. If the system is to reboot in any course, the system should restart itself within 60sec with resuming last settings once the course for failure is corrected
2.3	Accuracy	Static 2.5mm + 1ppm (Hz RMS) 5mm + 1ppm (Vertical RMS) RTK 10mm + 1ppm (Hz RMS) 20mm + 1ppm (vertical RMS)
2.4	Characteristics	GNSS Carrier tracking GNSS Code measurements Measurement precision Measurement Resolution GNSS measurements Fully independent code and phase measurements of all frequencies GNSS receivers must synchronize the actual instant of observation with true GPS time to within +/- 1 millisecond of the full second epoch.
2.5	Data Format	GNSS Receiver must be equipped to record phase and code measurements in all carriers and codes of available Global Navigation Systems Static data in RINEX 2.x, 3.x and other formats to be specified Real time data in RTCM2.x, RTCM3.x, NTRIP, NMEA 0183 and other formats to be specified Maximum number of data streams, streaming ports, data type and rates to be specified All available frequencies of positioning output should be indicated.
2.6	Memory & Data Recording	Data storage devices: Type & capacity to be specified to store 1second data logged for last 100days and 15second data for at least 2-year period. Capabilities of data transferring on HTTP download, FTP download & USB Should be specified
2.7	User Interface	All available user interface to be specified buttons/LEDs, Web interface, control software, operating system & its upgrades, internet connectivity. Etc.
2.8	Connectors, Ports and Devices	Connector ports & devices to be specified (RJ45 Ethernet port(10M/100M), SUPPORT TCP/IP, HTTP, NTRIP Protocol, RS232 Data port, multi-functional ports for system debugging and data copy from internal memory / SD card, parameters configuration and connecting with

No	Item	Specification Requirement
		meteorological sensor / tilt sensor, external storage disk. Event marker input port, external frequency scale port supports high – precision atomic clock. PPS output port, External power supply, etc.)
2.9	Weight and Dimensions	Weight & dimensions to be specified
3.0	Control System Architecture / Layout	
3.1	Central control software	Schematic diagram showing network architecture of the System including control Center, required hardware & software, operating system, data security, backup systems, etc. should be provided and functionality of each item in layout should be specified in detail. Size of the cabinet and capacity of loading at control center and SLCORSNet stations should be specified Survey Department will provide necessary infrastructure and location for server and control center at the surveyor General's office, Colombo.
4.0	Central Control Software	Specify the capability of control software on following aspects Capability to control & configure any CORS receiver of the system Comprehensive Graphical & numerical information of receiver & system Receive information and control of user operation in real time All Kinds of monitoring strategies Post Processing & network adjustments Basic Network integrity checking Network antenna Movements detection Data communication Operating System Etc., Post processing & network adjustment is expected in the control centre software to get the post processing & adjusted results.
5.0	Specifications for GNSS RTK Rover units	
5.1	GNSS Antenna	Antenna should be dust and water proof. Necessary adaptors / tribraches to mount receiver on standard tripod and poles Capability to use for Static Surveys Base or Rover in RTK surveys with internal UHF radio Base or Rover in RTK surveys with external Radio link Base or Rover in GPRS mode Rover in CORS mode
5.2	Tracking Capabilities	Should be as specified in 2.1, 2.2, 2.3, 2.4, 2.5, 2.7, 2.8, 2.9
5.3	Memory	Internal Memory 2GB and External Memory 2GB(minimum)
5.4	Controller	Full alpha numeric keypad with graphical daylight readable screen with back light. Graphical view of surveyed data, satellite tracked and signal strength, real time signal indicator. Display local coordinates using 7 parameter datum transformation and Transverse Mercator projection (provide details of the available Map projections, Datum and Features of graphical display) All available features and graphical displays of SLCORSNet stations should be specified. Rechargeable batteries and required chargers
5.5	Connectors, Ports and Devices	All available connector ports & devices for connecting to SLCORSNet for Static Surveys RTK Surveys etc should be available and availability of other features as specified in 5.1 to be specified. Rover receivers should have standard connecting ports for data communication such as Bluetooth, RS232 Port. USB, SD Card etc. and for external power supply.

No	Item	Specification Requirement
		Rover receivers should have all the capabilities mentioned in 5.1.
5.6	Power supply	Internal Re-Chargeable power supply capable of operating for 8 hours and more. Necessary chargers for recharging internal batteries (Input 100-240V AC50/60Hz) with cables. Optional item: Necessary cable for connecting receiver for external 12v DC power supply
5.7	Cable & accessories	For each Rover unit Controller, Transportation container, Cable for data transferring, Tribrach with optical plummet, tripod with strap for carrying, telescopic pole with circular level bubble and cradle to mount controller for RTK surveying.
6.0	Environmental Specification	All items should comply with international environment standards. Specifications to be provided. Operating Temperature: -20℃ ~ 60℃
7.0	Power and Electrical certification	UPS systems should be provide & must be capable of 24 or more power backup for uninterrupted operation of the system. Specification of the UPS system should be provided
8.0	Physical Safety	Protection system for lightening of Antenna, receiver and other connected instruments should be installed. Available anti-theft features to be specified, if any. Protection plan & system should be specified
9.0	Warranty	Minimum of 5 years Comprehensive warranty is required for the complete system including computers & all accessories. Plan for calibration of GNSS receivers and connected items should be submitted. Certification of the warranty & maintenance from the Manufacturer should also be submitted for evaluation.
10.0	Maintenance Plan	Five year warranty & the maintenance plan are required for the complete system including computers and all accessories. Bidder should be capable of handling routine services and repairs during warranty period and maintenance agreement period. Repair should be attended immediately. Maintenance agreement plan should be given for another 3 years after the 5-year warranty period. Plan for calibration of GNSS receivers and connected items should also be submitted.
11.0	Documentation	All technical broachers/manuals on CD’s providing all technical details and instructions. Software broachers/CD copies should contain all routine of the software and the overview of the software package. Operating manuals of the equipment for evaluation on request
12.0	Data communication Infrastructure	Wireless Broadband telecommunication facilities or most appropriate means of communication A redundant communication system between network receivers and Central Processing Center is also preferred. Required communication facilities from the service provider will be arranged & provided by the survey department of Sri Lanka. Provide all hardware & software required.
13.0	Future Expansion	Flexibility of the system to cater the future expansions of the CORS with different manufactures. Proposed SLCORSNet system should be able to expand in future to cover the whole island without upgrading it.
14.0	Available Receivers	CORS should support currently available receivers without any upgrading.

No	Item	Specification Requirement
		Available receivers should be configured & demonstrated. Receiver Types & Models available: Leica Viva dual frequency, Geodetic type GNSS receiver - 08 units Trimble R6 dual frequency, Geodetic type GNSS receiver - 24 units
15.0	Training	Sufficient training should be provided for functioning and complete operation of the system

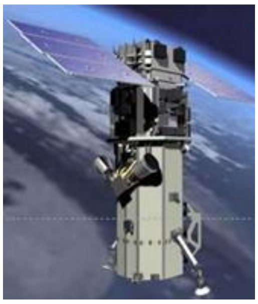
3.3.50cm Satellite Orthoimage Production

- High-resolution satellite orthoimages of the entire territory of Sri Lanka have uses as backgr ound maps for the national base map and the national spatial information system, and at the same time, they can be used as the core data of graphic cadasters to construct land inform ation.

- A variety of commercial satellite images can be used to produce 50cm high-resolution satell ite orthoimages, and multi-purpose satellites (KOMPSAT-1/2, a.k.a. Arirang-1/2) developed by Korea Aerospace Research Institute using Korean technology may be used.

- Typical commercial satellites from which images are collected and used include Digital Glo ve's WorldView-3, WorldView-4, and GeoEye-1, AirBus' Pleiades-1A and Pleiades-1B and Beijing Space View's SuperView-1/2/3. The characteristics of each satellite image are follo ws:

[Table V-13] Commercial Satellite Image Specifications

Digital Glove's WorldView-3/4		
Radiometric resolution	11-bits per pixel	
Resolution at acquisition	31cm	
Resolution at delivery	50cm	
Swath width	13.1km / 13.2km	
Revisit cycle	2.1 days	
Digital Glove's GeoEye-1		
Radiometric resolution	11-bits per pixel	
Resolution at acquisition	41cm	
Resolution at delivery	50cm	
Swath width	13.1km	
Revisit cycle	2.6 days	
Airbus's Pleiades-1A/1B		
Radiometric resolution	11-bits per pixel	
Resolution at acquisition	70cm	
Resolution at delivery	50cm	

Swath width	16.5km	
Revisit cycle	2.5 days	
Beijing Space View's SuperView		
Radiometric resolution	11-bits per pixel	
Resolution at acquisition	Pan 50cm, MS 2.0m	
Resolution at delivery	50cm	
Swath width	12.0km	
Revisit cycle	4.0 days	

- Korea's multi-purpose satellite (KOMPSAT) is a low-orbit Earth observation satellite with v arious sensors. Currently in operation are KOMPSAT-1 through 5, and KOMPSAT-6 with i mproved image radar performance and KOMPSAT-7 equipped with ultra-precision optical a nd infrared sensors are under development.

- KOMPSAT-3 is a high-resolution earth observation satellite equipped with an electro-optical camera with a resolution of 70cm that became the cornerstone of Korean commercial satell ite imagery. In March 2015, KOMPSAT-3A equipped with a mid-infrared sensor and a prec ision optical sensor was launched, and it is currently providing images comparable to those provided by commercial satellites.

- At present, KOMPSAT-3/5/3A are operating in a complementary manner and contributing t o the development of core technologies for the private use of satellite information and the p romotion of the satellite industry in addition to meeting the demand for satellite information.

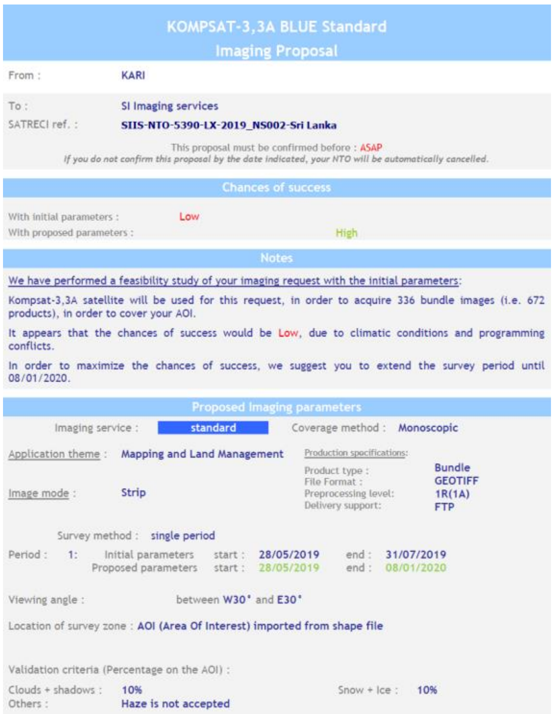
- It is expected to take around 8 months to provide satellite images of the entire territory of Sri Lanka using the multi-purpose satellites, with complementary shooting by KOMPSAT-3/ 3A. This is deemed a reasonable amount of time to shoot and supply new images to be use d for building land information on Sri Lanka.

- Also, it will be possible to supply new satellite images of the entire territory of Sri Lanka at half the cost of what is generally charged for commercial satellite images, and this optio n is deemed satisfactory in terms of both time and cost.

- The new satellite image supply plan proposed by the Korea Aerospace Research Institute, t he operator of the multi-purpose satellites, is as follows:

[Table Ⅴ-14] KOMPSAT-3/3A Image Proposal

Image service	Standard
Coverage method	Monoscopic
Application theme	Mapping and Land Management
Image mode	Strip
Product type	Bundle
File Format	GeoTiff
Preprocessing level	1R(1A)
Viewing angle	W30° ~ E30°
Clouds + Shadows	10%
Snow + Ice	10%



KOMPSAT-3,3A BLUE Standard
Imaging Proposal

From : KARI

To : SI Imaging services
SATRECI ref. : SIIS-NTO-5390-LX-2019_NS002-Sri Lanka

This proposal must be confirmed before : ASAP
If you do not confirm this proposal by the date indicated, your NTO will be automatically cancelled.

Chances of success

With initial parameters : Low
With proposed parameters : High

Notes

We have performed a feasibility study of your imaging request with the initial parameters:

Kompsat-3,3A satellite will be used for this request, in order to acquire 336 bundle images (i.e. 672 products), in order to cover your AOI.

It appears that the chances of success would be Low, due to climatic conditions and programming conflicts.

In order to maximize the chances of success, we suggest you to extend the survey period until 08/01/2020.

Proposed Imaging parameters

Imaging service : standard Coverage method : Monoscopic

Application theme : Mapping and Land Management

Production specifications:
Product type : Bundle
File Format : GEOTIFF
Preprocessing level: 1R(1A)
Delivery support: FTP

Image mode : Strip

Survey method : single period

Period : 1: Initial parameters start : 28/05/2019 end : 31/07/2019
Proposed parameters start : 28/05/2019 end : 08/01/2020

Viewing angle : between W30° and E30°

Location of survey zone : AOI (Area Of Interest) imported from shape file

Validation criteria (Percentage on the AOI) :

Clouds + shadows : 10% Snow + Ice : 10%
Others : Haze is not accepted

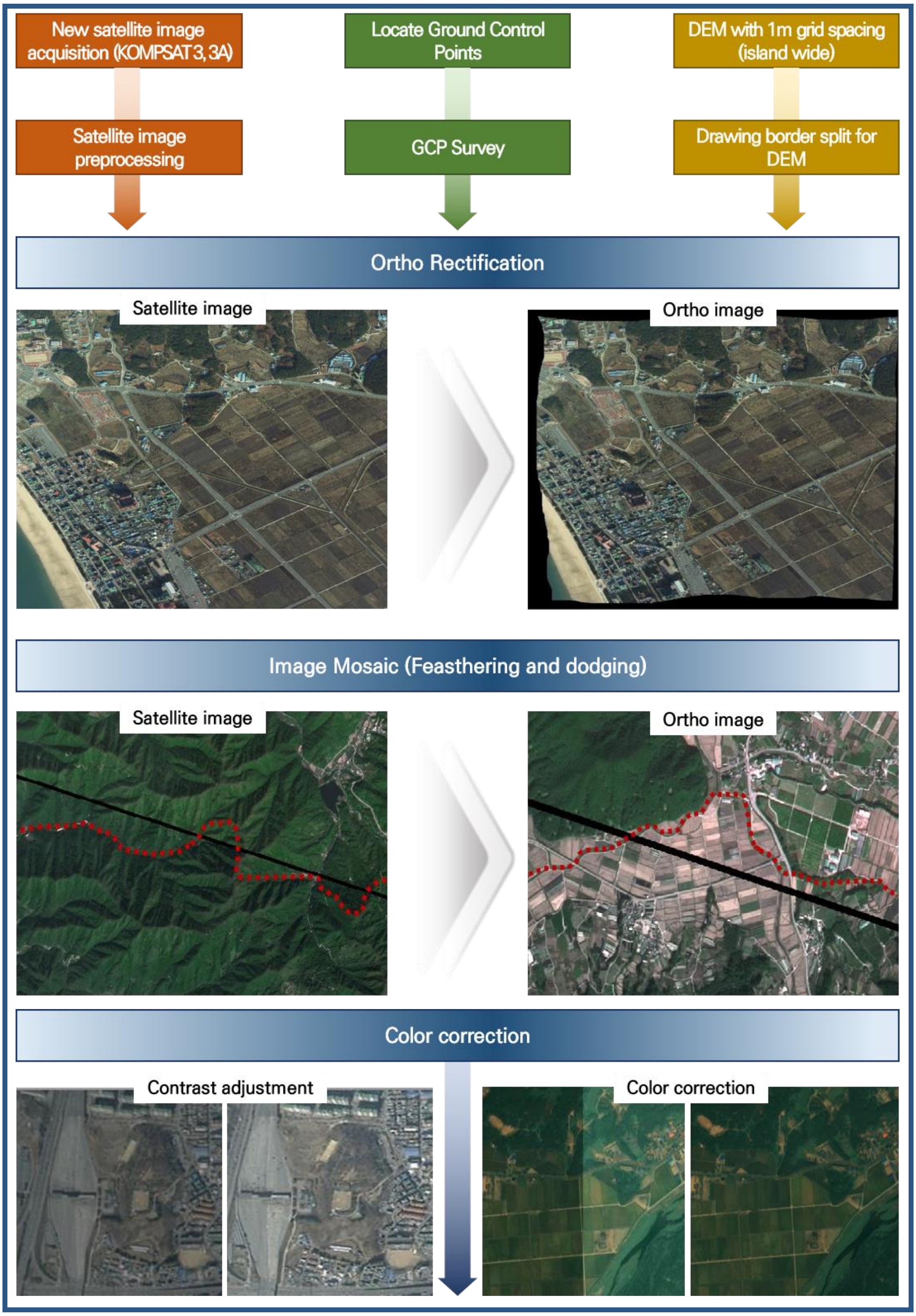
❍ Due to the marine climate of Sri Lanka, if the cloud is more than 10% of the newly recorded KOMPSAT-3/3A satellite image, commercial satellite image (Pleiades-1A/1B from Airbus or GeoEye-1 from Digital Global) should be used. Complementary use pre prepares supplementary measures for acquiring new images.

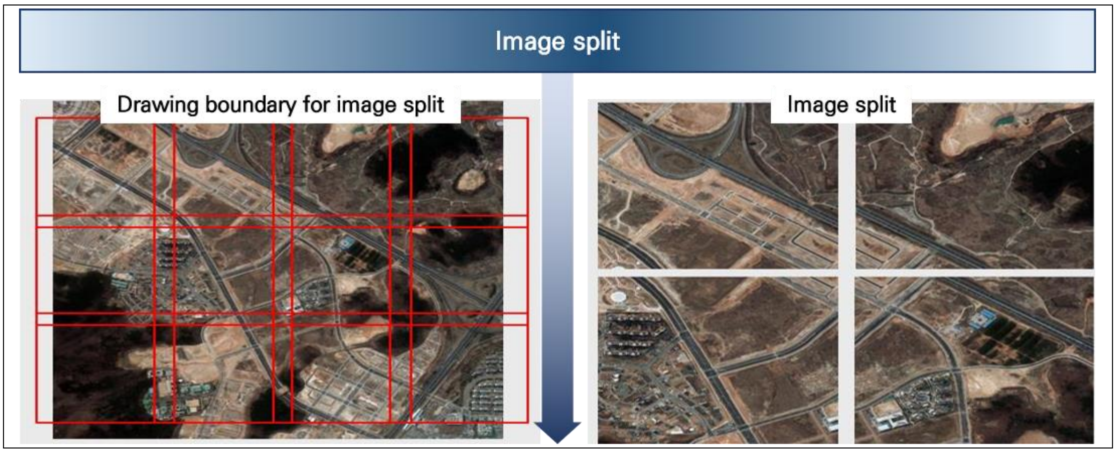
❍ In the case of mountainous areas with little change in terrain, the KOMPSAT-3/3A satellite image obtained before this project can be used, which is determined through the process of checking and verifying the image together with the Survey Department of Sri Lanka

❍ The production of satellite orthoimages covering the entire territory of Sri Lanka will be based on the new images shot by KOMPSAT-3/3A. Ortho rectification will be performed using monoscopic images and 1m grid digitial elevation model (DEM) will be used to ensure ease of the production process.

❍ The DEM for ortho rectification of 50cm satellite images need to have coverage of the entire territory of Sri Lanka and must be within the average square root error of 3m with absolute vertical accuracy at 1m grid spacing.

❍ The 50cm satellite image production process using the new images produced by KOMPSAT-3/3A and the latest 1m grid DEM is as follows:


New satellite image acquisition (KOMPSAT 3, 3A)
Locate Ground Control Points
DEM with 1m grid spacing (island wide)
Satellite image preprocessing
GCP Survey
Drawing border split for DEM
Ortho Rectification
Satellite image
Ortho image
Image Mosaic (Feasthering and dodging)
Satellite image
Ortho image
Color correction
Contrast adjustment
Color correction



[Figure Ⅴ-16] Satellite Orthoimage Production Process

❍ KOMPSAT-3/3A provide the RPC(Relational Polynomial Coefficients) information for acqui ring the ground coordinates from satellite image. The RPC information is used for interior orientation, but because it contains errors, the errors are eliminated by using the ground con trol point information.

❍ Generally, the RPC information is used to remove the constant error component included in the satellite images, while the ground control point information is used to remove the rand om errors with non-planar distortions.

❍ Differential rectification (ortho rectification) is performed using the exterior orientation resul ts from using the ground control points and the digital elevation data at 1m grid interval. T his is the process of eliminating displacements and/or distortions in the subjects that occur during satellite imaging and projecting all the points on the ground vertically on to paper.

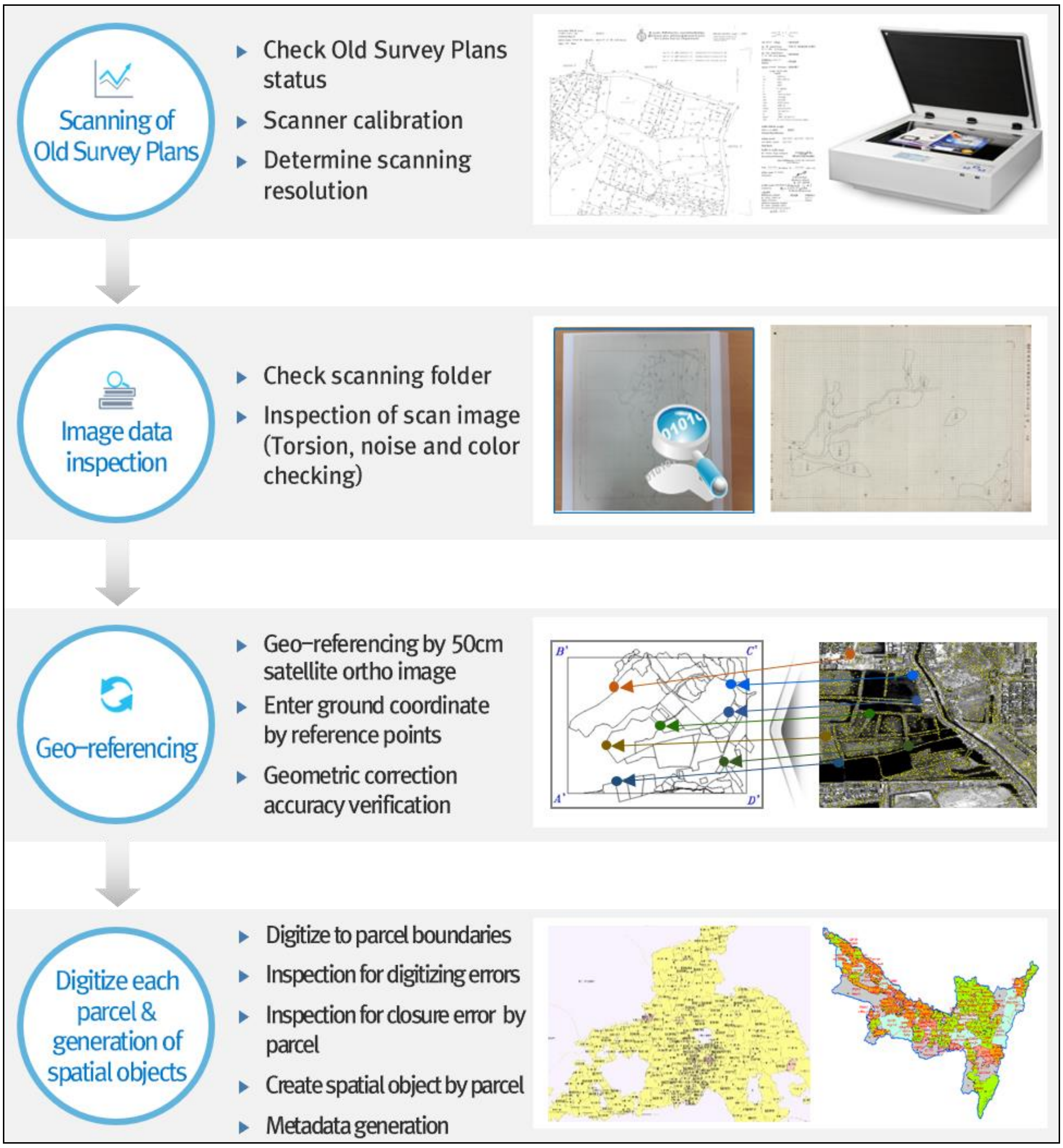
❍ The mosaic production process is a process carried out to ensure the continuity of roads, str eams, valleys, mountain ridges, etc. to maintain geometric continuity at the junctions betwee n adjacent images, and by ensuring continuity, elongation between images is minimized and resolution is maintained.

❍ The color correction process is a process of minimizing the color variation between adjacen t images so as to ensure a uniform color throughout the satellite orthoimages, and applying standardized colors for each type of terrain by performing color histogram matching for the entire image. This process improves quality by adjusting the contrast value of the satellite orthoimages and emphasizing details.

❍ Considering the use of satellite orthoimages, quadrangles for each scale to be partitioned ar e created in the process of partitioning images based on the large-scale drawin doundary sta ndards of Sri Lanka, and accordingly, the images are then partition according to the scale-b y-scale contour that you want to divide into a process that divides the image according to t he map sheet. When partitioning images, there should be at least 1cm extra space compared to the size of the drawing boundary.

3.4.Computerization of Old Survey Plans

❍ The computerization process for the Old Survey Plans is divided into the drawing scanning process, geo-referencing process for the scanned suvey plans, and digitizing process for eac h parcel. The results are then prepared following an inspection after each process.



[Figure Ⅴ-17] Satellite Orthoimage Production Process

❍ There are currently 82,303 sheets of Old Survey Plans managed and stored by the district s urvey offices operating under the SDSL. All of them have been scanned, but they must be analyzed so that they can be classified according to their condition (scanning quality) and l ow-quality ones must be re-scanned.

- The scanned survey plans are divided into high-quality scan, average-quality scans and low-quality scans. Low-quality scans account for 10% of the total amount, and they need to be re-scanned.

- As for the ground coordinates of the reference points that can be checked on the scanned survey plans, the ground coordinates extracted from the 50cm satellite orthoimages should be used. Ground coordinates for at least six reference points should be entered for each survey plan.

- Using 50cm satellite orthoimages, ground coordinates of the reference points should be entered, and geo-referencing of the scanned survey plans should be carried out through a 2D affine transformation using the ground coordinates of the reference points that have been inputted. At the same time, the accuracy of the geo-referencing should be verified by analyzing the residual and root mean square error of the reference point coordinates after the 2D affine transformation.

- The vectorization process which involves digitizing the boundaries of each parcel included in the geo-referenced image files and forming them into a polygon is performed by screen digitizing and closing process.

- The verification of the accuracy of the digitized data consists of determining whether the RMS error of the digitized lines is within 1 pixel of the scanned image and checking for any misclosures.

- The checklist for assessing the quality of the data that have been vectorized through the digitizing process is as follows:

① Check for the Overlaps
② Check for the Gaps
③ Check for Silver Polygons[29]
④ Check for Undershoot, Overshoot/Dangles
⑤ Check for unclosed polygons
⑥ Check for polygon contiguity due to bad edge matching
⑦ Check for line continuity due to digitizing of lengthy lines
⑧ Check for unique identification number of a land parcel (lot number)
⑨ Check the generated nodes against the point description in the image
⑩ Check the annotation data against the symbols in the images
⑪ The generated extent of the digitized land parcels should be checked with the legal extent written in the TL (Tenementary Lists).

- Spatial objects are generated and spatial object attribute information is inputted based on the information from the hard copy or scanned tenementary lists provided by the SDSL.

① Plan Number
② Total number of parcels
③ Total extent of parcels in the Plan

[29] Silver polygons are generally but not necessarily triangular features with one or two of the internal angle very near to 0°. They are generally formed due to bad snapping. No silver polygon should be present

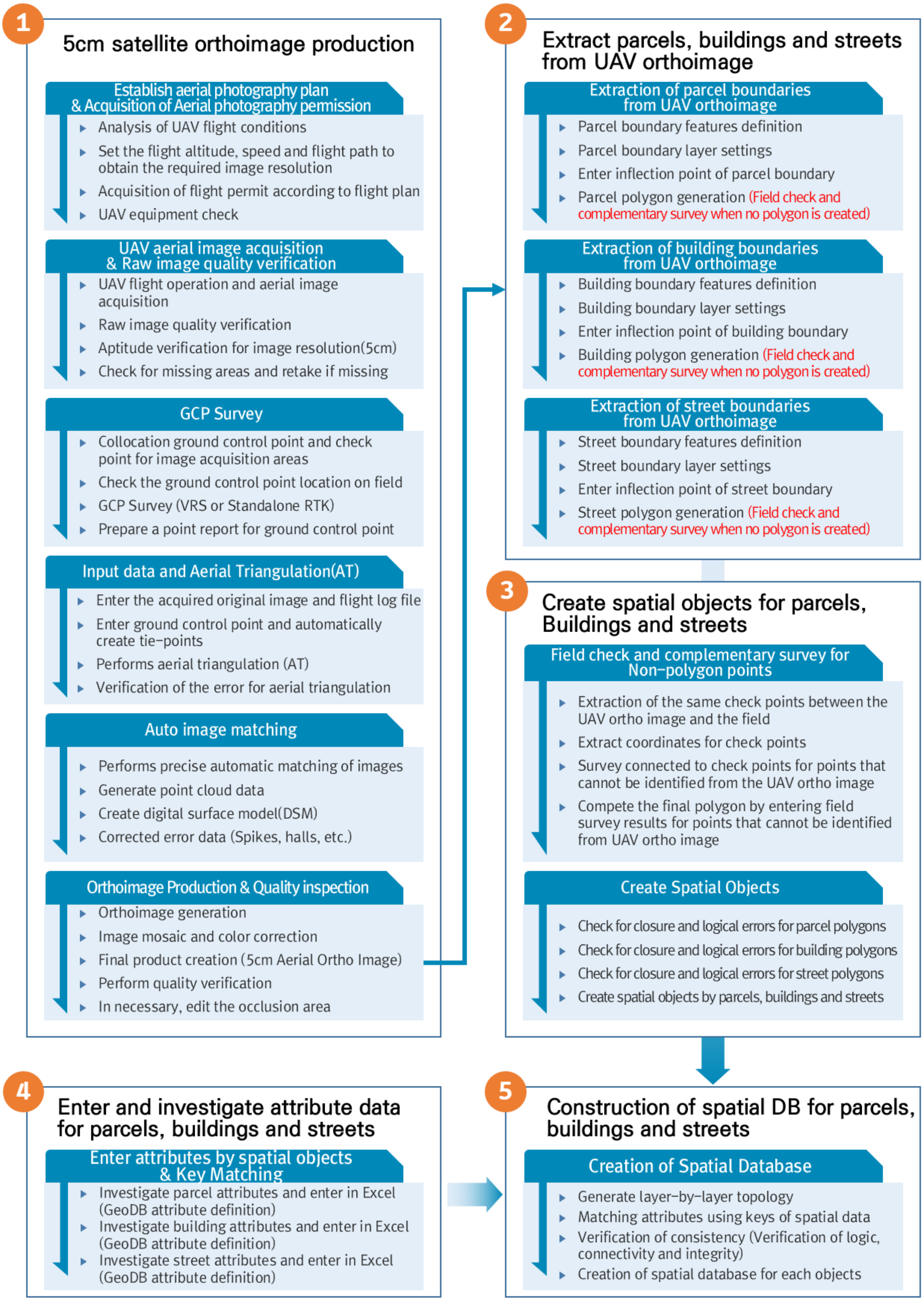
④ Lot Number
⑤ System Extent (Automatic Extraction)
⑥ Legal Extent
⑦ Extent Difference [System Extent - Legal Extent]
⑧ Compiled by [name of the service provider] & Signature & Date []
⑨ Accepted on [date] by [name of the officer]
⑩ Any other remarks

- The computerization process of Old Survey Plans is completed by generating metadata with respect to the final digital files.

3.5.Construction of Land and Spatial Databases for 24 MCs

- The spatial database for the parcels, buildings, and streets of 24 major municipal councils (MCs) will be established based on spatial data extracted from 5cm aerial orthoimages.

- The series of processes involved in setting up the spatial database includes: ① process of pro ducing 5cm orthoimages by UAV aerial photogrammetry, ② process of extracting parcels, bui ldings and streets from 5cm orthoimages, ③ process of performing field complementary surve y and generating spatial data for unextracted boundary points, ④ process of examining and in putting attribute information on parcels, buildings, and streets, ⑤ process of creating a spatial database by structured editing. The final output is derived after inspecting the results of each step.



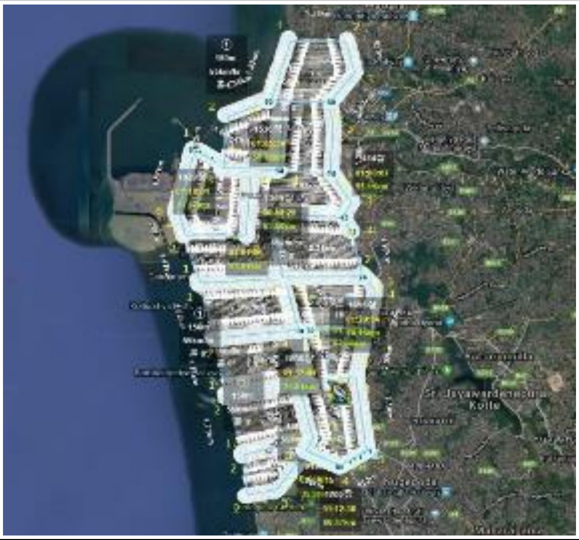
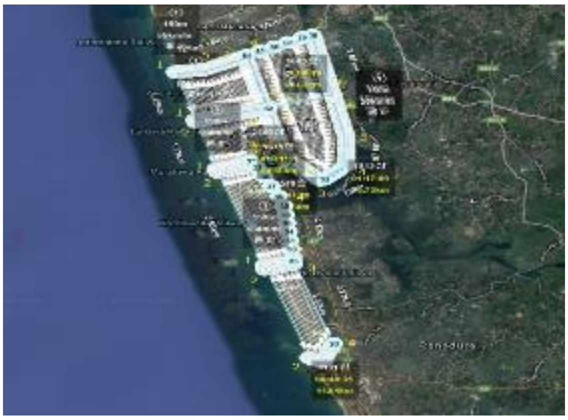
[Figure Ⅴ-18] Spatial DB Construction Process for 24 Major MCs

① The UAV flight plan for producing 5cm aerial orthoimages for the 24 MCs established the shooting plan based on a fixed-wing UAV in consideration of the area required by each MC. Estimates of flight volume and the number of aerial images for each MC were made based on a flight elevation of 150m, flight speed of 55km/h, and end/forward overlap of 75%, and side lap of 65%.

[Table Ⅴ-15] Quantity of Unmanned Aerial Images for Each of the 24 MCs

Municipal Council	Sortie	Flight distance (Km)	Flight time (min)	Number of images
Colombo Municipal Council	14	869.03	947	22,210
Dehiwala-Mount Municipal Council	7	432.67	472	11,061
Kaduwela Municipal Council	27	1,797.60	1,962	45,892
Moratuwa Municipal Council	6	362.27	395	9,258
Sri Jayawardanapura Kotte Municipal Council	7	372.87	407	9,520
Gampaha Municipal Council	11	608.13	661	15,517
Negombo Municipal Council	11	672.15	731	17,167
Kurunegala Municipal Council	5	283.10	308	7,239
Jaffna Municipal Council	12	581.68	634	14,770
Kandy Municipal Council	9	549.90	600	14,024
Dambulla Municipal Council	19	1,144.15	1,246	29,042
Matale Municipal Council	4	240.50	263	6,139
Nuwaraeliya Municipal Council	4	291.45	317	7,441
Anuradapura Municipal Council	23	1,296.40	1,415	32,819
Polonnaruwa Municipal Council	12	759.35	824	24,77
Baticaloa Municipal Council	15	816.43	897	20,890
Akkaraipattu Municipal Council	2	128.04	140	3,264
Kalmunai Municipal Council	9	575.99	628	14,729
Galle Municipal Council	7	413.70	450	10,575
Matara Municipal Council	8	412.43	513	12,001
Hambantota Municipal Council	25	1,685.93	1,839	43,129
Rathapura Municipal Council	8	526.10	574	13,426
Badulla Municipal Council	4	255.39	279	6,521
Bandarawela Municipal Council	4	204.01	233	5,202

[Table Ⅴ-16] Flight Plan for Each of the 24 MCs

Colombo Municipal Council	Dehiwala-Mount Municipal Council
	
Kaduwela Municipal Council	Moratuwa Municipal Council
	
Sri Jayawardanapura Kotte Municipal Council	Gampaha Municipal Council
	
Negombo Municipal Council	Kurunegala Municipal Council

Jaffna Municipal Council

Kandy Municipal Council

Dambulla Municipal Council

Matale Municipal Council

Nuwaraeliya Municipal Council

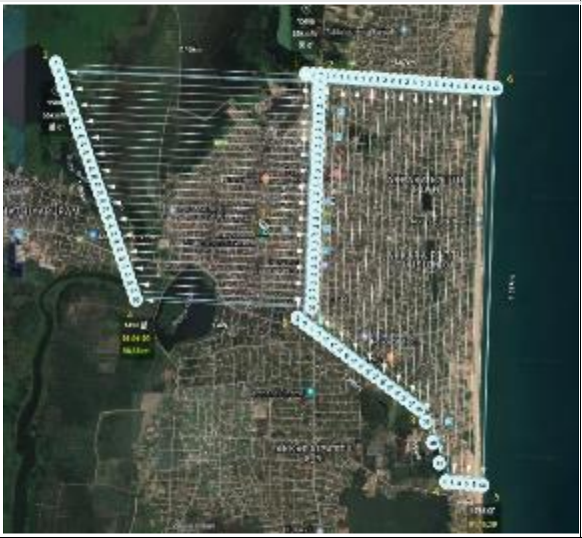
Anuradapura Municipal Council

Polonnaruwa Municipal Counci

Baticaloa Municipal Council

Akkaraipattu Municipal Council

Kalmunai Municipal Council



Galle Municipal Council

Matara Municipal Council

Hambantota Municipal Council

Rathapura Municipal Council

Badulla Municipal Council

Bandarawela Municipal Council

– UAV survey consists of work planning stage, ground control point selection/survey stage, UAV flight/data acquisition stage, data processing stage, and final production stage. In order to localize Sri Lank of UAV survey technology, local engineers are introduced along with Korean engineers throughout the entire process.

① The screen digitizing method is applied to extract the boundaries of parcels, buildings, and streets using 5cm aerial orthoimages, while applying the boundary feature layers defined in the Digital Data Management Work Regulations of the SDSL.

[Table V-17] SDSL's Boundary Features Layer Definitions

Layer	Feature (Line)
1. BOUND_LM_GEN	Boundaries defined with Landmarks
2. BOUND_B_GEN	Bank
3. BOUND_BUND_GEN	Bund
4. BOUND_BW_GEN	Boundary Wall
5. BOUND_DF_GEN	Dry Fence
6. BOUND_DT_GEN	Ditch
7. BOUND_EDN_GEN	Earth Drain
8. BOUND_HG_GEN	Hedge
9. BOUND_IF_GEN	Iron Fence
10. BOUND_LF_GEN	Live Fence
11. BOUND_MY_GEN	Masonry Drain
12. BOUND_RW_GEN	Retaining Wall
13. BOUND_SF_GEN	Stone Fence
14. BOUND_WLF_GEN	Wire Line Fence
15. BOUND_WE_GEN	Wetiya
16. BOUND_WF_GEN	Wire Fence
17. BOUND_WLF_GEN	Wire Live Fence
18. BOUND_WNF_GEN	Wire Net Fence
19. BOUND_TB_VIR	Transferred boundary
20. BOUND_U_GEN	Indefinite boundary
21. BOUND_W_GEN	Wall
22. BOUND_TE_GEN	Tar Edge
23. BOUND_C_GEN	Curb
24. BOUND_RG_GEN	Ridge
25. BOUND_RI_GEN	Road Isle
26. BOUND_OTHER_GEN	Other type of boundary
27. BOUND_OUTER_GEN	Outer Boundary

– The definitions of the parcel boundaries identifiable on 5cm aerial images are as follows:

[Table Ⅴ-18] Parcel Boundary Definitions Based on 5cm Aerial Orthoimages

Boundaries of Land Parcels	
01. Wall: W	Land parcels are mostly covered by walls
	Almost all the walls appear as straight lines
	Mostly perpendicular to each other
	Thickness is about 9 inches
	Mostly appear in white color
02. Boundary Wall: BW	Common wall that separate two houses
	Can be clearly observed because boundary wall continues from house edge until to a wall
	Thickness is about 9 inches
	Mostly appear in white color
03. Masonry Drain: MDn	Appear as double lines which run parallel
04. Live Fence: LF	Mostly appear in green color
	Leaves can be seen with a specific pattern
	Thick straight lines
05. Road: R	Where the boundary of the land parcel runs along the edge of the road
06. Stream: S	Where the boundary of the land parcel runs along the edge of a stream/river

– The boundary of a building should be within the parcel boundary, and each spatial object is extracted according to the logical principle that any street boundary should not exist inside a parcel.

– If parcel, building or street boundaries cannot be identified due to obstacles such as trees on the 5cm aerial orthoimages, such should be classified as a not-confirmed point and it should be updated based on on-site complementary survey.

– According to the results of a pilot project conducted by Land and Geospatial Informatrix Corporation in 2017, it will be possible to identify more than 70% of the parcel boundaries when parcel boundaries are extracted based on 10cm UAV aerial orthoimages of the pilot project area (cities and rural areas of Sri Lanka).

– Based on the results of a pilot project conducted by Land and Geospatial Informatrix Corporation in 2017, this project estimated the unconfirmed boundary points from aerial orthoimges as 20% of the total boundary points. This is because the aerial orthoimage(5cm GSD) produced in this project is much higher in resolution then the aerial orthoimages (10cm GSD) applied to the pilot project, and simultaneously extracts the boundaries of the parcels, buildings and streets.

– On-site complementary survey for not-confirmed points that cannot be identified in the aerial orthoimages due to obstacles such as trees are performed using the field complementary survey that connects the not-confirmed points with confirmed points.

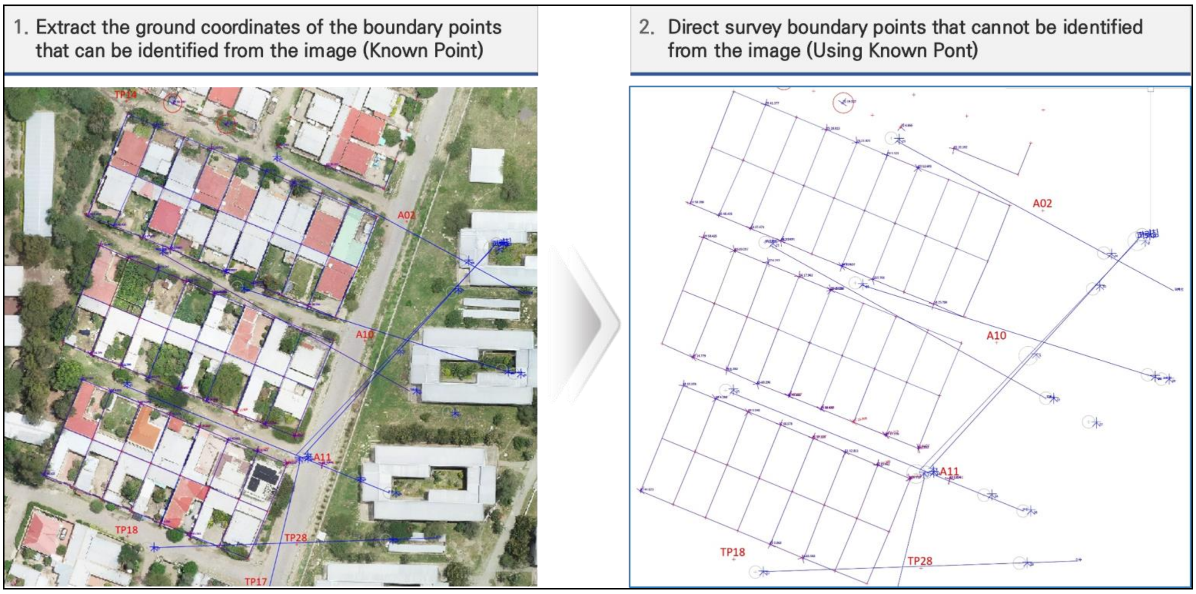
– Generally, not-confirmed points exist in areas where trees are concentrated and in most cases, the boundaries of spatial objects cannot be identified because they are hidden by trees during vertical aerial photography

– In this project, it is estimated that about 20% of all boundary points cannot be identified in 5cm grade aerial orthoimages, and field complementary surveys are conducted for those boundary points.

– When using the GPS survey method for survey the boundary points covered by trees, accuracy cannot be guaranteed due to GPS signal interruptions caused by the trees.

– Therefore, traverse survey using a total station should be carried out. For the known points, the ground coordinates of the stations that have been confirmed based on orthoimages are used.

– Provides an on-site survey support system (including Pen-Computer and On-site Survey Support S/W) to extract boundary points that can be identified from aerial orthoimages in the field directly for the on-site complementary survey, and to use the extracted points as known points to conduct traverse surveys more effectively.



[Figure Ⅴ-19] On-Site Complementray Survey for Non-Confirmed Points

– The ground coordinates of not-confirmed points are acquired through on-site complementary survey, and the coordinates are connected with the confirmed points identified via the orthoimages so as to create spatial objects in the form of polygons for parcels, buildings and streets.

– For each spatial object for parcels, buildings and streets, the results are determined by checking the spatial data such as inspection of continuity and integrity of parcels the logical inspection of the buildings and streets.

① The attributes of spatial objects of parcels, buildings, and streets are setup according to the data model that is redefined through this project. Attribute information is built through the process of classifying, examining, and refining the attribute items defined in the data model.

– The cadastral data model and sporadic data model defined by the SDSL are used as the data models, and the LIS data model including the unique numbers of parcels (parcel ID, asset number and asset street) are used.

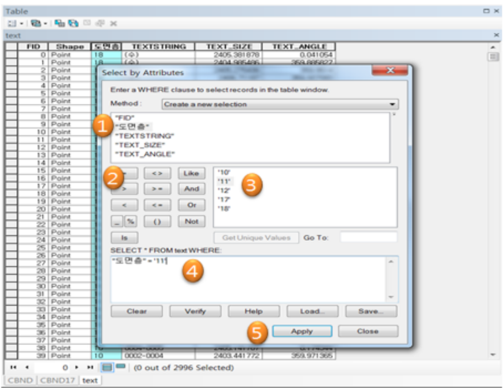
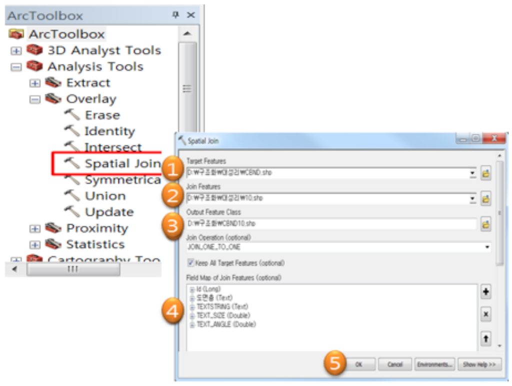
– As for attribute classification for attribute inspection, attributes are classified into common attribute elements included in all parcels, buildings and streets and independent attribute elements included only in the spatial objects of parcels, buildings and streets.

– The data of the management agencies (MCs, UDA, RDA, SDSL, etc.) in relation to the attribute items are collected through a process of inquiry, copying, etc. and organized into Excel files according to the attribute classification.

– The attribute items examined and collected are assigned a spatial object ID after the process of refining each spatial object.

– The final attribute information is built through the process of checking whether the refined attribute information matches the spatial object.

② Structured editing is a process of joining spatial objects with attribute information corresponding to each spatial object. The final spatial database of parcels, buildings, and streets is built by checking the completeness, connectivity, logic, and integrity of spatial information and attribute information.

Select by Attributes	Spatial Join
	
1. Select layer 2. Select operation '=' (equal) 3. Select '11' (ex, Land Use) 4. Express the selected condition 5. Apply	1. Select the objects to join (ex, parcels) 2. Select attribute data item 3. Input SHP filename to save 4. Delete unnecessary fields 5. OK

[Figure Ⅴ-20] Structured Editing

3.6.Provision of Equipment for Survey and DB Construction

❍ The equipment used for setting up the land and spatial databases for Sri Lanka LIS operati on and for raising the efficiency of ongoing database update is divided into computer equip ment and survey equipment.

❍ The main computer equipment consists of PCs for building a spatial database from digitizati on of Old Survey Plans and UAV aerial orthoimages and workstation equipment for ongoin g data management and updates.

- The main computer equipment consists of 5 PCs for database construction and 1 workstatio n for DB management and updates for each of the 25 district survey offices operating unde r the SDSL. Such computer equipment is the equipment for processing and management of survey data of divisional survey offices. It maximizes the efficiency of the work by managi ng UAV raw data as well as satellite orthoimages acquired through this project. The list of computer equipment introduced is as follows:

[Table Ⅴ-19] Specifications and Quantity of Equipment Introduced to District Survey Offices

Category	Equipment	Specific	Quantity
Computer equipment	PC	CPU: 3.6GHz 2Core or higher Mem: 32GB or higher HDD: 1TB or higher Graphic: Navidia® GTX1050 2GB Monitor: 27-inch or higher	125
	Workstation	CPU: 3.6GHz 4Core × 2ea Mem: 64GB or higher HDD: 1TB 10K SAS × 2ea Graphic: Radeon Pro or higher Monitor: 27-inch or higher	25

- The main computer equipment will be used first for digitizing old survey plans and buildin g the spatial databases for the 24 MCs. The computer equipment for database setup and the workstation equipment for management purposes will be handed over to the district survey offices upon completion of the digitization and database construction process.

- During the hand-over a checklist for the manufacturers' warranty period extension certificat e, equipment performance test, and equipment list will be prepared, and presence of potenti al problems will be checked. In addition, consumables are replaced with new ones.

- The main survey equipment is comprised of unmanned aerial surveying equipment for conti nuously expanding the scope of 5cm aerial orthoimage production which is currently confin ed to 24 MCs a well as GNSS survey equipment, total station survey equipment and pen-co mputer which facilitate ground control point survey and land survey.

- The main survey equipment consists of 1 set of GNSS surveying equipment, 1 set of total s tation, and 1 unit of pen-computer for each of the 25 district survey offices. To apply new survey technology using UAVs, 5 sets of UAV survey equipment (including 10 sets of data processing SW and workstation) are assigned to the SDSL to support various UAV survey s.

[Table Ⅴ-20] Specifications and Quantity of Equipment Introduced to SDSL

Category	Equipment	Specifications	Quantity	Remarks
UAV surveying equipment	Fixed-wing UAV	- Drone (fixed wing – up to 90 min of flight each time) - RGB camera sensor - GCS (Ground Control System) - Ground control communications module - Drone storage box - Drone maintenance and repair tools - Battery and charger	5 sets	
	Data processing workstation	- CPU: 3.6GHz 4Core × 2ea - Mem: 64GB or higher - HDD: 1TB 10K SAS × 2ea - Graphic: Radeon Pro or higher - Monitor: 27 inch or higher	10 sets	
	Data processing S/W	- Drone image data processing software - Spatial data extraction and editing software		
GNSS surveying equipmen	GNSS receiver	- All-in-one 200-channel antenna receiver or higher - GPS, GLONASS, Galileo, et. L1/L2 - Positioning accuracy - Static: Horizontal - 3mm+0.5ppm RMS Vertical - 5mm+0.5ppm RMS - RTK: Horizontal - 10mm+1ppm RMS Vertical - 20mm+1ppm RMS - Network-RTK: Horizontal - 10mm+0.5ppm RMS - Vertical - 20mm+0.5ppm RMS	25 sets	Guaranteed compatibility with the equipment at CORS reference stations
	GNSS controller	- OS: Windows Mobile Professional - CPU: ARM Cortex A8 Processor - Memory: 256MB Ram or higher		
Total Station surveying equipment	Specification	- Precision: 2 initial readings - Dual axis corrector: correction range – 6 sec - Minimum display: 1 initial readings/5 initial readings - O/S: Linux - Display: Graphic LCD, 192×82 backlight	25 sets	
	Components	- Main body: 1set - Built-in rechargeable battery: 1EA - Charger: 1EA - Power cable - Lens cap - Lens hood - Tool pouch, etc.		

Category	Equipment	Specifications	Quantity	Remarks
Pen-Computer		- CPU: Intel Core i7-5600U or higher - LCD: 13.1 or higher - Memory: 8GB or higher - HDD: 500GB or higher - Battery: up to 18 hours or higher - Supported interfaces: USB2.0/3.0, memory card slot, HDMI/VGA/Serial Port, etc.	25 set	

- With the installation of 32 additional GNSS stations set up for the CORS Network, equipm ent that is directly compatible with the GNSS equipment to be set up at the GNSS station will be introduced to ensure the accuracy of Network-RTK.

- The UAV survey equipment will be deployed first during the production of aerial orthoima ges for the 24 MCs so that the persons in charge of the district survey offices can administ er training together, and field training will be provided in parallel to prevent problems in eq uipment operation and data processing.

- The total station and pen-computer will be used in field complementary survey of the boun dary points of not-confirmed parcels, buildings, and streets on 5cm aerial orthoimages. Dire ct field training is conducted in parallel to avoid problems in using the on-site survey supp ort system connected with the total station such as reading and input of ground coordinates of the confirmed points.

- The main survey equipment is used first for land and space database construction and hand ed over to the persons in charge at the district survey offices after the database is construct ed when field training of the persons in charge is finished.

- During the hand-over a checklist for the manufacturers’ warranty period extension certificat e, equipment performance test, and equipment list will be prepared, and presence of potenti al problems will be checked. In addition, consumables are replaced with new ones

- Promotion Organization and Personnel

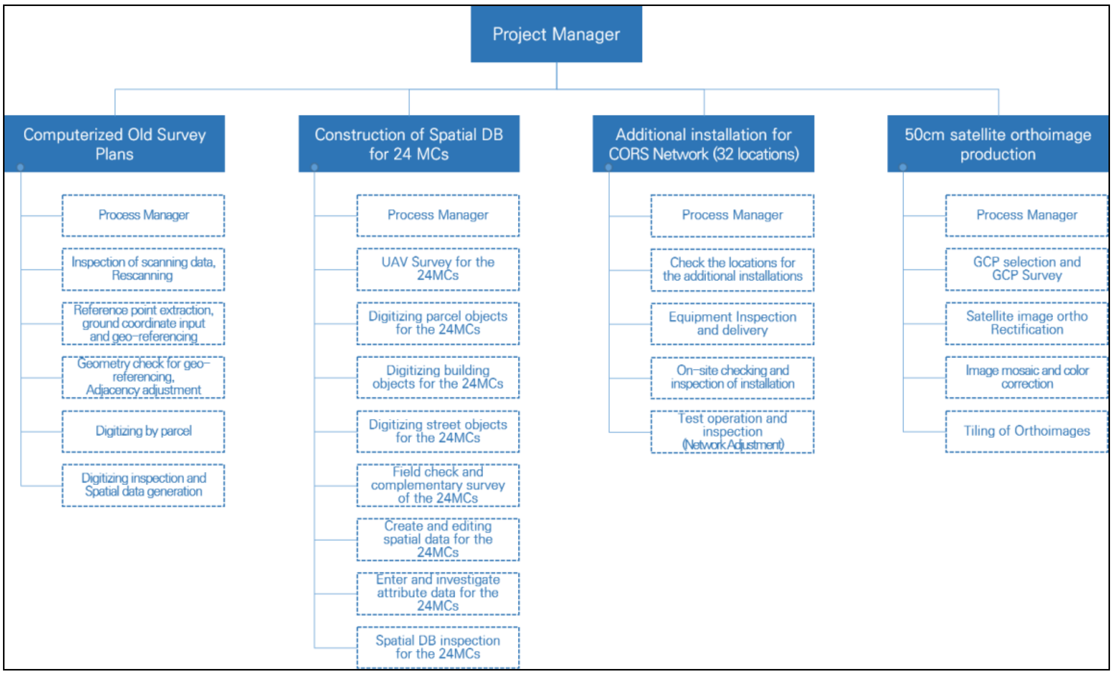
- The land and spatial information DB parts for the Sri Lanka LIS are divided into the organ ization that performs the actual data construction and the organization at the SDSL that ma nages and supervises data construction.

- The organization implementing this project will be comprised of a Project Manager (special -class technician) for the land and spatial information DB parts and two process managers (one special-class technician and one advanced technician) for each part to manage the qual ity, schedule, risks and issues for each process.

- To ensure the smooth implementation of the project and to check, manage and supervise th e quality, schedule and issues, a process supervisor for each part will be appointed among t he database supervising officers at the SLSD to perform management and supervision.

❍ Since the work, data acquisition and management will be carried out all across Sri Lanka, supervising manpower for each process will be assigned to each the district survey office under the SDSL so that management and supervision can be performed in a smooth, coordinated manner.

❍ The organizational structure for the land and spatial information DB part is as follows:



[Figure Ⅴ-21] Organization Chart of Land and Spatial Information DB part

[Table Ⅴ-21] Personnel Composition for Organization of Land and Spatial Information DB part

Category	Process	Implementing organization		SDSL
		Korean technician	Local technician	
Database construction	Project Manager	1 person (special-class)	-	1 person from SDSL
Computerization of Old Survey Plans	Process manager	1 person (special-class) 1 person (advanced)	-	1 person from SDSL
	Inspection of scanned data	2 people (intermediate)	5 people (advanced) 5 people (intermediate)	1 person from each District Office (a total of 25 people)
	Rescanning of poor-quality scanned data			
	Reference point extraction, ground coordinate input and	10 people (intermediate)	100 people (intermediate)	

Category	Process	Implementing organization		SDSL
		Korean technician	Local technician	
	geo-referencing			
	Geometric check for geo-referenced data and adjacency adjustment			
	Digitizing by Parcel	10 people (intermediate)	200 people (intermediate)	
	Digitizing inspection and spatial data generation		100 people (intermediate)	
Construction of spatial DB for 24 MCs	Process manager	1 person (special-class) 1 person (advanced)	-	1 person from SDSL
	UAV survey for 24 MCs	40 people (advanced)	48 people (intermediate)	1 people from each District Office (a total of 25 people)
	Digitizing parcel objects for 24 MCs	10 people (intermediate)	200 people (intermediate)	1 person from each District Office (a total of 25 people)
	Digitizing building objects for 24 MCs			
	Digitizing street objects for 24 MCs			
	Field check and complementary survey of 24 MCs	10 people (intermediate)	199 teams (1 team-3 people)	
	Create and edit spatial data for 24 MCs		200 people (advanced)	
	Enter and investigate attribute data for 24 MCs			
	Spatial DB insepection for 24 MCs		30 people (advanced)	
Additional installation for CORS Network (32 locations)	Process manager	1 person (special-class)	-	1 person from SDSL
	Check the locations for the additional installations	1 person (special-class) 1 person (advanced)	2 people (intermediate)	1 person from SDSL

Category	Process	Implementing organization		SDSL
		Korean technician	Local technician	
	Equipment inspection and delivery	1 person (special-class) 1 person (advanced)	2 people (intermediate)	2 people from SDSL
	On-site checking and inspection of installation	1 person (special-class)	10 people (intermediate)	2 people from SDSL
	Test operation and inspection (network adjustment)	1 person (advanced)	-	2 people from SDSL
50cm satellite orthoimage production	Process manager	1 person (special-class)	-	1 person from SDSL
	GCP selection and GCP survey	2 people (advanced)	30 people (advanced)	2 people from SDSL
	Satellite image ortho rectification	2 people (advanced) 1 person (intermediate)	-	1 person from SDSL
	Image mosaic and color correction	1 person (advanced) 1 person (intermediate)	-	
	Tiling of orthoimages	1 person (advanced) 1 person (intermediate)	-	

4.Land Information System Plan

4.1.Work Process Modeling

- The most important and frequently performed land-related tasks are land are land registration and land sub-division(amalgamation).
- More than 1,000 land registration applications are submitted to each regional office (LSD) via Bim Saviya a day.
- Currently, only 4% of all private lands in Sri Lanka (1.2 million parcels) have been registered, which is equivalent to about 45,000 titles. Also, land subdivision is a suitable procedure for identifying private land alterations, but only the approval of the local authority (MC) is necessary for subdivision and information is not shared among the related agencies, which slows down the process of determining the current status of land information in Sri Lanka.
- In work process modeling, the aim is to determine the status of land registration and privat

e land alterations by modeling land registration and land subdivision work procedures

4.1.1.Title Registration

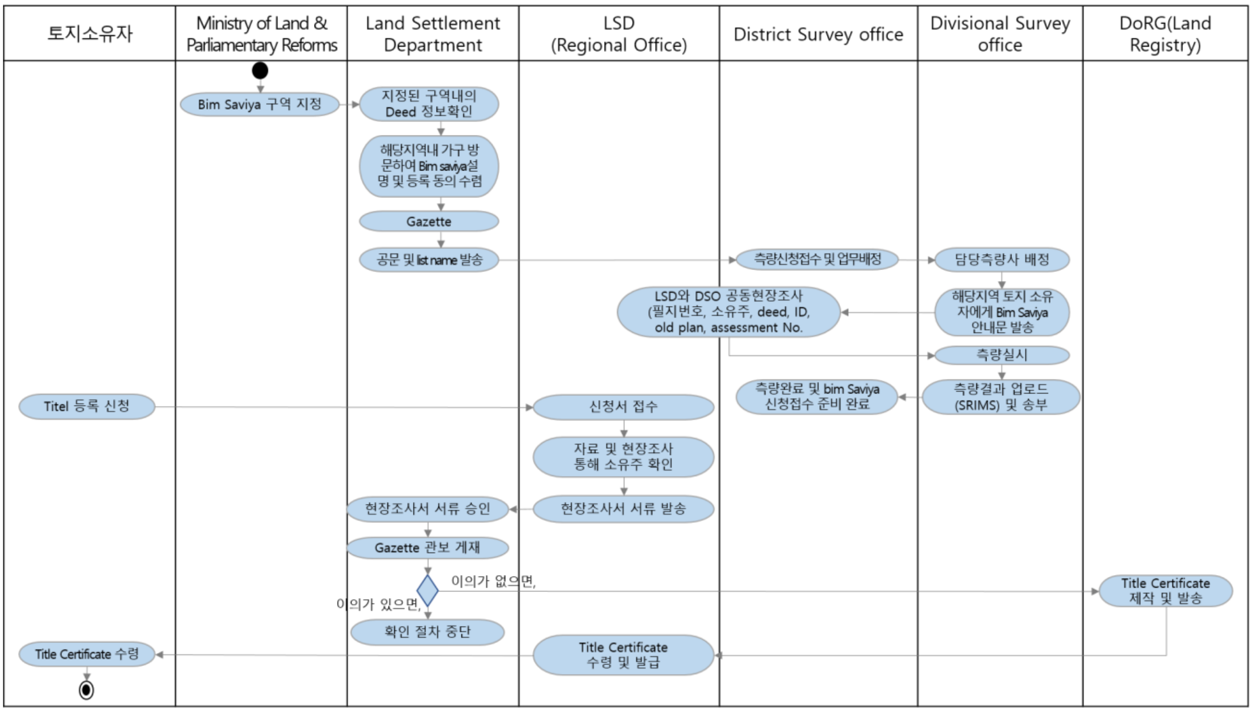
❍ The government of Sri Lanka is inducing title registration through the Bim Saviya program. Ministry of Land and Parliamentary Reforms (MoLPR) selects the target areas and carries out the program.

❍ When the MoLPR selects a target site, the LSD and the SDSL begin surveying the target si te and the landowner, and upon completion, a registration application is accepted.

❍ The landowner visits the regional office of the LSD with jurisdiction to submit an applicati on for title registration, and when the application is approved following a field survey by th e regional office (LSD), the details are confirmed through a gazette and the landowner is is sued a title certificate.

❍ The main tasks of each institution in the current title registration process are as follows, an d the related work processes are shown in [Fig. Ⅴ-21].

– Ministry of Land and Parliamentary Reforms (MoLPR): Select the target areas of Bim Saviya and notify there
– LSD: Promote the Bim Saviya program in the target area, check the landowner information, and receive consent
– District survey office (SDSL): Receive surveying applications, assign divisional office and check surveying
– Divisional survey office (SDSL): Assign surveyors, conduct surveys, and upload surveying information
– Regional office (LSD): Acquire land registration applications, check landowner information through field surveys, and issue title certificates
– Land Registry (DoRG): Issue title certificates



[Figure Ⅴ-22] Title Registration Procedure Model (As-Is)

- ❍ After the setup of the LAS, there is a new function for the relevant entities to share inform ation and notify each other of the completion of certain work processes during the registrati on process, thereby saving time and labor.

- ❍ The MoLPR selects the target area for Bim Saviya and sends notices to all the relevant enti ties through the LAS.

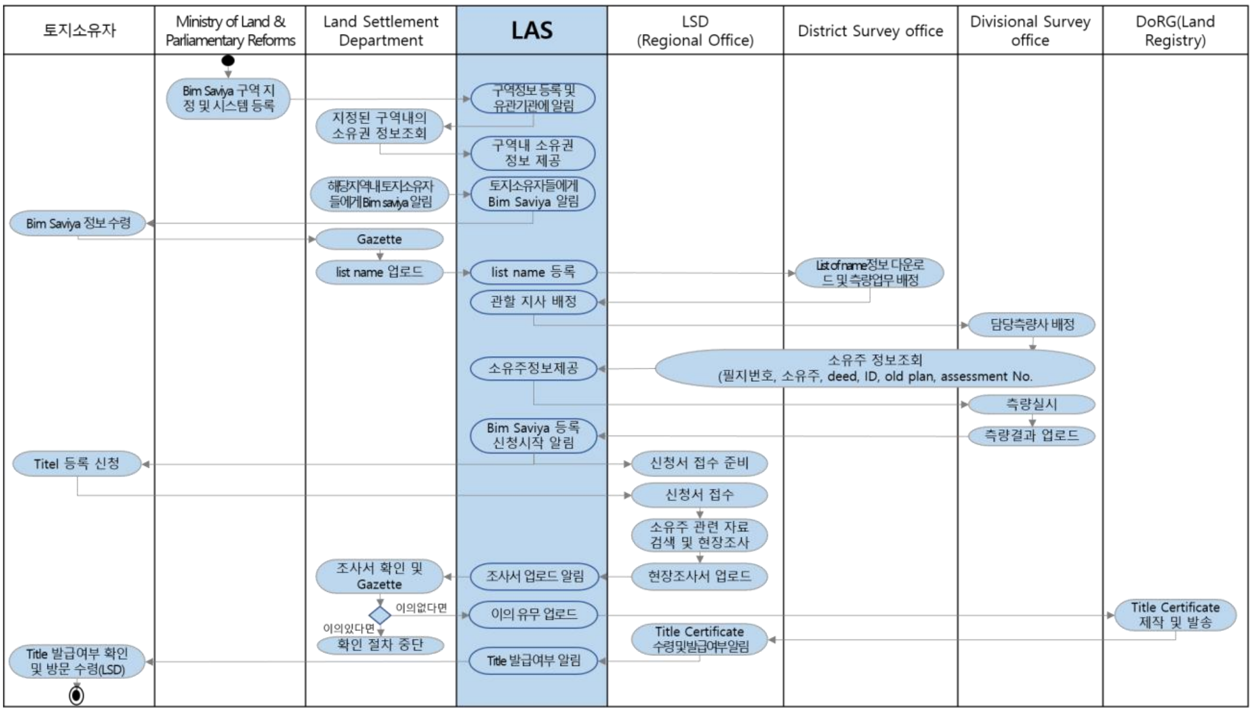
- ❍ The LSD logs on to the LAS to look up the ownership information for the designated area and inform the landowners in the target areas selected for the Bim Saviya program through the LAS.

- ❍ The SDSL carries out surveying to prepare for title registration.

- ❍ The details of the field surveys jointly conducted by the regional office (LSD) and the divis ional survey office are shared by relevant entities through the LAS.

- ❍ Afterwards, when the title registration application is notified to the landowners, the regional office (LSD) receives registration applications and approves of them following a field surv ey for the landowners to be issued title certificates.

- ❍ The direction for improving the main procedures of each entity in the to-be model for title registration are as follows, and the land-related processes are shown in [Fig. Ⅴ-22].
  - – MoLPR: Share target area information through LAS
  - – LSD: Check landowner information through LAS and obtain consent
  - – District survey office (SDSL): Receive surveying applications through LAS, designate the divisional survey office in charge and inspect surveying results
  - – Divisional survey office (SDSL): Assign surveyor through the LAS, upload surveying information on LAS and share plans with relevant entities
  - – Regional office (LSD): Receive land registration application through LAS, check owner information through a field survey and share information by uploading it on the system
  - – Land Registry (DoRG): Notify applicant of the issuance of title certificate through the LAS



[Figure Ⅴ-23] Title Registration Procedure Model (To-be)

4.1.2.Subdivision

❍ Land in Sri Lanka is divided into state-owned land and subdivision of private land. Private land is further divided into land in a cadaster area and land in a sporadic area. In the case of subdividing private land, the landowner can hire a licensed surveyor, who then performs surveying for subdivision and submit a survey plan to the SDSL to be checked and approved. One approved, the applicant can receive a survey plan where the subdivision has been approved.

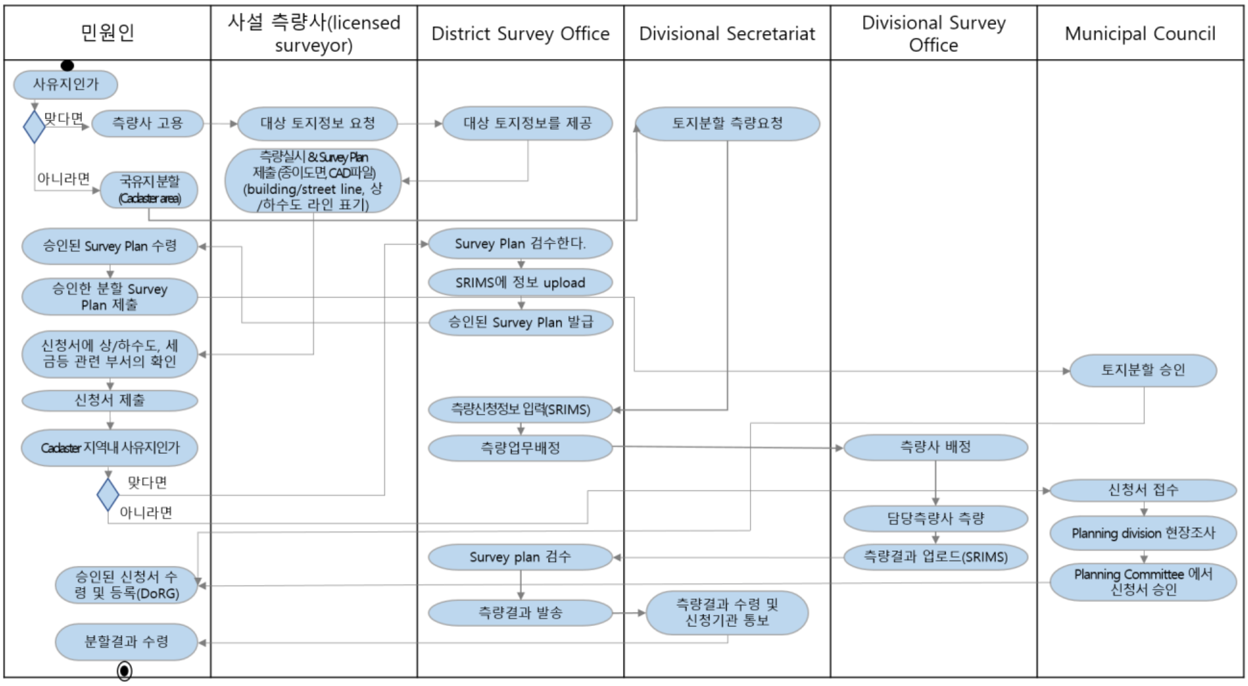
❍ If a survey plan is submitted to the local authority and approved and registered with the land registry, the title of the subdivided land can be received.

❍ In the case of subdividing state-owned land (within the cadaster area), the applicant entity files an application to the SDSL through the Divisional Secretariat, and the SDSL sends the results through the Divisional Secretariat after surveying.

❍ At present, the main tasks of each entity in the land subdivision process are as shown in [Fig. Ⅴ-23].

– Registered licensed surveyor: Create a plan by requesting site information and conducting surveying
– District survey office (SDSL): Check and approve of the produced plan, assign the surveying work for subdivision of the state-owned land, and send surveying results
– Divisional Secretariat: Request the district survey office to perform surveying for subdivision and notify the results to the requesting entity
– Divisional survey office (SDSL): Assign a surveyor and conduct the surveying for subdivision
– Local authority (MC): Receive application for subdivision of private land, conduct a field survey

on ownership, and approve of subdivision

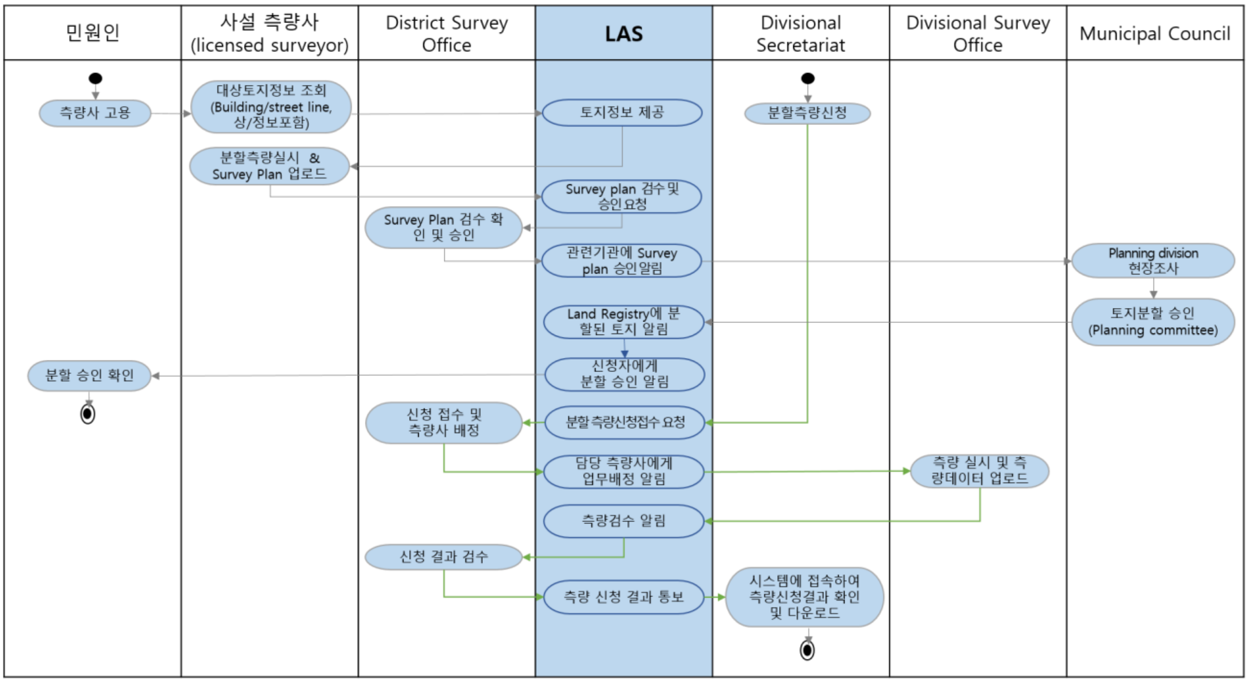


[Figure Ⅴ-24] Subdivision Procedure Model (As-is)

❍ Once the LAS is established, it will inform the relevant entities of the completion of the preliminary tasks, as is the case with the land registration process, and the entities can download various information via the system, thereby saving a considerable amount of time and money.

❍ As for the to-be model for subdivision of state-owned land, applications for surveying for subdivision are received by the LAS via the Divisional Secretariat, and the SDSL receives the survey application and performs surveying for subdivision. Plans that have been inspected can be downloaded from the Divisional Secretariat via the LAS.

❍ In the case of subdividing private land, the applicant hires a surveyor who then logs on to the LAS to search for information on the target site When the surveyor performs surveying for subdivision and uploads the survey results on the LAS, the system requests the SDSL to check the results. Once the results are checked and approved by the SDSL, the local authority is notified of the approval, and subdivision is approved after a field survey. Then, the LAS notifies the relevant entity (i.e. Land Registry) and the applicant of the approval of subdivision.



[Figure Ⅴ-25] ubdivision Procedure Model (To-be)

– Registered licensed surveyor: Look up information on the target site on the LAS and upload the survey plan on the LAS

– District survey office (SDSL): Check and approve of survey plans via the LAS, assign surveying of state-owned land, and send survey results

– Divisional Secretariat: Receive applications for surveying for subdivision through the LAS and request surveying and report the results to the district survey office.

– Divisional survey office (SDSL): Assign a surveyor via the LAS, conduct surveying for subdivision and upload surveying data

– Local authority (MC): Receive applications for subdivision of private land, look up information on ownership via the LAS, and notify the applicant after approval of subdivision via the LAS

4.2.Data Model Definitions

❍ The composition criteria for data and attribute field names in the newly proposed tables or tables with newly added attributes are identical as the existing naming rules.

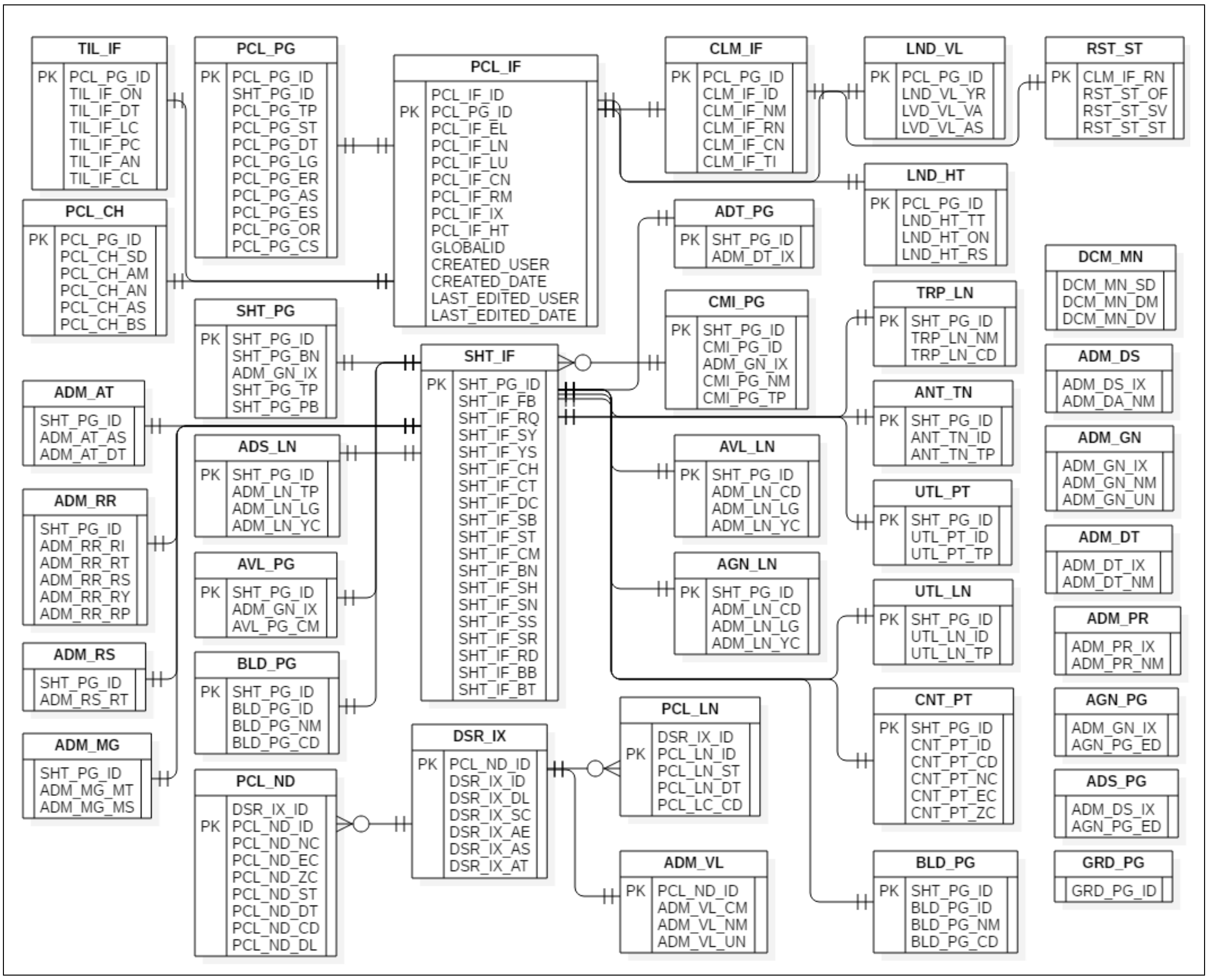
❍ In addition to the existing table, new tables have been proposed for land price, history man agement, applicant information management, applicant processing status, title information m anagement, management of changes in information resulting from land alterations, and docu ment registration and management, and tables for land administration and it also includes th e corresponding attributes.

[Table Ⅴ-22] Added Tables

Table	Definition	Attribute
LND_VL	Land price information table: Management of information on land price assessment year, valid period on assessment results, and assessed value	YR: Assessment year VA: Valid period AS: Assessed value
LND_HT	History management table: Management of information on the history of changes in the title, change of owner, and reason for change	TT: Title history ON: Owner history RS: Reason for change
CLM_IF	Applicant information management table: Applicant ID number, applicant name, applicant registration number, contact number, and tax payment information	ID: ID No. NM: Applicant name RN: Application registration number CN: Contact number TI: Tax payment information
RST_ST	Application processing status table: Management of information on the department and person in charge of handling applications and processing status	OF: Office (dept. in charge) SV: Service representative (person in charge) ST: Processing status
TIL_IF	Title information management: Management of information on the titleholder (owner), ownership acquisition date, target site location and parcel number, assessment number, and title class	ON: Owner information DT: Title acquisition date LC: Target site location PC: Parcel information AN: Assessment number CL: Title class
PCL_CH	Table for managing information registration and changes resulting from land registration and movement (subdivision, merger, etc.): Management of information on various types of land alteration such as land subdivision and merger, donation of state-owned land, and expropriation	CT: Title alteration type BS: Title registration
DCM_MN	Document registration and management table: Management of information on document types (scanned documents, etc.) and versions, and metadata	CT: Document type DM: Document metadata DV: Document version
ADM_AT	Administrative source type	AS : administration sources DT : administration type
ADM_RR	Right, Restriction, Responsibility	RI : right RT : restriction RS : responsibility RY : tight type RP: responsibility type
ADM_RS	Required relationship between administration unit	RT: relationship type
ADM_MG	Mortgage for certain land	MT: mortgage type MS: mortgage source

4.2.1.Data Model Architecture

- Relationships were established by adding a primary key to the existing tables, and relations hips for data reference purposes were established by adding a primary key to the newly add ed tables. The following figure shows a diagram of the overall data model relationships.



[Figure Ⅴ-26] Data Model ERD

4.3.Definitions of Subsystem and Unit System

4.3.1.Land Administration System

❍ The land administration system consists of a land registration system for registering land an d cadastral maps, a cadastral map management system, a document management system, an d a land information inquiry system that uses land information. It also includes a surveying application management system for managing surveying applications and persons in charge of surveying, a field surveying system for efficient execution of cadastral surveys, and a s urvey performance inspection system and survey performance management system for effici ent management of cadastral survey results. Additionally, an image basemap management sy stem is set up to manage output from UAV and satellite image and utilize to business proc ess

❍ The definitions of the modules of each system and their detailed functions are as follows:

A) Land Registration System

– The land registration system is for registering land titles and receiving and registering landowner information as well as civil applications concerning land subdivision, merger, and other alterations. It is designed to allow users to check for the existence of a parcel and applicants to be issued title certificates. The detailed functions of the land registration system are as follows:

[Table V-23] Detailed Functions of the Land Registration System

Category	Main function	Detailed functions
Receiving applications	Civil application management	Register, edit, search (list), or delete civil applications
		Temporarily save or delete civil applications
		Check return, or approve of applications and issue certificates
		Create, edit or delete a transaction
		Send application result (e-mail or SMS)
	Title-related applications	Create, edit, or view title registration/change application
		Create, edit, or view owner information
	Land alteration applications	Create, edit, or view new parcel registration application
		Create, edit, and view parcel subdivision application
		Create, edit, and view parcel merger application
		Create, edit, and view parcel boundary alteration
	Attribute change	Create, edit, and view registered information correction application

Category	Main function	Detailed functions
Registration	Transaction management	Search or export list of transactions
	Title registration	Register, edit, delete or manage the history of title
		Change owner information and manage the history of changes in owner information
	Parcel editing and registration	Register, edit, delete or manage the history of parcel subdivisions
		Register, edit, delete or manage the history of parcel mergers
		Register, edit, delete or manage the history of parcel boundaries
	Correction of registered matters	Register, edit, delete or manage the history of corrections of registered matters
Approval	Transaction approval	Approve, return or cancel transactions
	Printing certificate	Print or manage the history of land certificates

b) Cadastral Map Management System

– The cadastral map management system is a system that manages cadastral maps, administrative boundaries and other graphs by generating phases after importing cadastral survey data, creating parcels, and performing parcel subdivision, parcel merger, and parcel boundary correction. It plays the role of a system for checking the existence of parcels on the land registration system, in addition to exporting cadastral maps in the form of shape files. The detailed functions of cadastral map management system are as follows:

[Table Ⅴ-24] Detailed Functions of the Cadastral Map Management System

Category	Main function	Detailed function
Transaction	Manage transactions	Initialize, load, remove, save, complete, cancel, accept, return and restore transactions
Surveying data	Import surveying data	Import and save DXF
		Import and save txt files
		Create and save polygon phases
Parcel management	Subdivide parcels	Select parcel for subdivision and draw boundary lines for subdivision
		Subdivide parcel figure
		Manage history
	Merge parcels	Select parcels for merger and merge parcel figures
		Manage history
	Create parcels	Draw parcel boundaries and save
		Manage history
	Update parcel	Update surveying area, land use, etc.

Category	Main function	Detailed function
	information	
	Edit parcel boundaries	Edit parcel boundary lines
		Manage history
Graph management	Create boundary points and buildings	Select parcel and create boundary points
		Save boundary point file
		Enter building coordinates
		Enter building attributes
Administrative divisions	Edit administrative divisions	Edit Province, District, Divisional Secretariat Division, Grama Niladhari Division
Output	Output drawings	Output drawing/PDF
	Export cadaster	Export cadastral map shape files within a specific administrative district
		Export cadastral map shape file for the area of interest
Setting	Set parcel editing options	Define topology rules and minimum area

c) Document Management System

– The document management system is a system for scanning and registering documents and field notes submitted along with the survey results. The documents scanned together with the cadastral maps are managed so that they can be looked up quickly when inquiring land information. Detailed functions of document management system are as follows:

[Table V-25] Detailed Functions of the Document Management System

Category	Main function	Detailed function
Document management	Document search	Search document metadata
	Document management	Manage document versions
		Register, edit, or delete document metadata
		Delete document (PDF/JPG)
Document registration	Document scanning	Scan, preview, and rescan (with adjusted resolution) documents
		Temporarily save (PDF) and delete
		Save scanned image
	Document attachment	Preview document
		Upload documents and save the list of attached files
Document view	Quick inquiry	View thumbnail image
	Default image inquiry	Basic inquiry, zoom-in, zoom-out, move, and view all
Document	Image editing	Rotate, adjust size, crop

Category	Main function	Detailed function
editing		Remove noise, adjust brightness, correct tilt
Settings	Code management	Add, edit or delete document codes
	Document access management	Register, edit, or delete document access information
	Scanner connection	Standard scanner drive interface
		Scanner connection settings

d) Land Information Inquiry System

– The land information inquiry system is a system for looking up registered cadastral information and queries past history to utilize them for various administrative tasks. It consists of a function for displaying cadastral statistical information in connection with spatial data as various thematic so that they can be used easily and conveniently. The detailed functions of the land Information inquiry system are as follows:

[Table Ⅴ-26] Detailed Functions of the Land Information Inquiry System

Category	Main function	Detailed function
Land information	Basic land information inquiry	View basic information on parcels
		View history of land alterations
		View status of land alterations and readjustments
		View history of changes in land rights
		View the assessed value of real estate property
		View title registration status
Cadastral control points	Cadastral control point management	View, register and update cadastral control points
		Manage cadastral control points as a single file
Quadrangles	Quadrangle management	Create and update quadrangles
Usage status inquiry	Land information inquiry status	History of land information inquiries
		Statistics on the status of land information inquiries
Statistical management	Issuance history	View history of issuance
		View issuance statistics (by day, month, region)
	Land use status	View statistics on land use by administrative district
	Land rights status	View statistics by land rights category by administrative district
	Surveying status	View surveying statistics
Policy support	Thematic maps	Basic status of land by theme
Policy support	Thematic maps	Comprehensive status by theme (input search conditions)
		Status by theme (input search conditions)
	Cadastral policy information	Save cadastral policy information file

Category	Main function	Detailed function
		View, register and update records of providing policy information
	Road opening support	View information on the drawings of road opening
		View information on parcels provided for road opening
	Calculation of land purchase tax	View a zoning map of purchased land
		View report on calculation of land purchase tax
	Report for each lot number	View parcel analysis drawings
		View report by lot number

e) Survey Requisition Information Management System

– The surveying application information management system is a system for receiving surveying applications from civil applicants and institutions and assigning surveying tasks to survey technicians, and it is comprised of functions for managing the priorities of surveying applications, assigning surveyors, and uploading surveying data. The detailed functions of the surveying requisition information management system are as follows.

[Table Ⅴ-27] Detailed Functions of the Surveying Requisition Information Management System

Category	Main function	Detailed function
Management of surveying application	Receive application	Register surveying applications
	Priority assignment	Search and prioritize surveying applications
	Termination of requested surveying	Cancel, edit, return or terminate surveying results
	Selection of monthly target	Enter the monthly target workload for each surveyor
	Check for pending surveying applications	Check the list of pending surveying applications and change status (pending -> in progress)
	Search	Search for surveying in progress/completed survey/pending surveying, search for surveying work by surveyor, and search for unauthorized tasks
Surveying management	Surveyor assignment	Assign surveyor
	Surveyor editing	Delete/update surveyor information
	Surveying application update	Update requested surveying information, assign work to the branch in question, and change assigned branch
	Calculation of monthly target	Calculate monthly target workload for each surveyor
	Report	Report on economic feasibility, summarized report on completed surveying, report on the number of new surveying cases, report on the best surveying work of the month, report output (Excel)

Category	Main function	Detailed function
Surveying data management	Surveying data upload	Upload surveying data

f) Survey Results Management System

– The survey results preparation system is a system for preparing cadastral survey results by UAV and T/S. It includes functions for performing survey calculations, saving results, and preparing drawings and reports. It is connected with the function of registering cadastral survey results through the cadastral registration system. The detailed functions of the survey results management system are as follows:

[Table Ⅴ-28] Detailed Functions of the Survey Results Management System

Category	Main function	Detailed function
Surveying calculations	Registration of observation data	Import (surveying results, file loading, coordinate registration)
		Save as Excel (set number of digits and select file format)
		Register boundary points (point number, coordinate registration, application, save)
	Linear line calculations	Register reference points (point registration, start point/end point check/save)
		Register intermediate points (point registration, intermediate point check/save)
		Calculate linear line (calculation, deviation check, Excel save)
		Calculate center line (line/left point/right point selection/check/save)
	Center line calculations	Create center line (line selection, check/save calculation section on Excel)
		Calculate center line (select/check/save center line)
	Station point of center line calculations	Create center line (drawing/registration, check/save calculation section on Excel)
		Select/calculate station point of center line in use (select four points, enter specifications)
	Block calculations	Register calculation points (select block, check/save calculation section on Excel)
		Select/calculate center line (select three points, enter road width/specifications)
	Block angle calculation	Register calculation points (select block, check/save calculation section on Excel)
		Select/calculate arc (radius, azimuth angle of starting point/end point, specifications)
Surveying calculations	Curve calculations	Register calculation points (inner/outer block, check calculation section on Excel)
		Select/calculate arc (radius, azimuth angle, curve name, specifications)
	Curve width calculations	Calculation/drawing (select coordinates, enter point

Category	Main function	Detailed function
		number, check calculation section)
	Vertical line calculations	Register used points (register two points, select intermediate point)
		Calculate/save (register points, enter block number, check calculation section)
		Register used points (register two points, enter distance, block number)
	Linear coordinates calculations	Calculate/save (linear coordinates, check/save calculation section on Excel)
		Register boundary corner points (select/save block/boundary corner points)
Saving results	Calculation point registration	Manage boundary points (copy and paste, register and save point number/coordinates)
		Change layer (enter block number, select/save parcel)
	Boundary point connection	Automatic connection (enter block number, check/save attribute information)
		Enter results (enter boundary point results, apply all results)
	Results preparation	Extract results (check/verify/save results, save outputs)
		Import (select/check/loading Coordinates)
Coordinate system	Single coordinate system (unified origin)	Set type (set/save STT, NTT, IGN)
		Apply (automatically generate the coordinate system, control points, and layers)
		Import (select/check/loading Coordinates)
	Local coordinate system	Set type (set/save coordinate system used locally)
		Apply (automatically generate the coordinate system, control points, and layers)
		Run (register results file, check/save surveying results)
Preparation of drawings and reports	Survey result (before inspection)	Setting (district name, output type, distance between points, text size, etc.)
		Create (check/save drawings, field information, surveying results drawing)
		Partial drawing (select control point/scale, check/save content)
		Run (register results file, check/save surveying results)
	Survey result (after inspection)	Setting (name, output type, distance between points, text size, etc.)
		Create (check/save drawings, field information, surveying results drawing)
		Partial drawing (select control point/scale, check/save content)
	Preparation of related drawings	Set/save confirmed Plan (large-scale surveying drawing)
		Set/save large-scale surveying within the district
		comparison of parcel information before and after surveying
		boundary map of the district subject to surveying
	Preparation of related	Confirmed area report (results report on the parcel area)

Category	Main function	Detailed function
	reports	New and old land report (report on the parcel area before and after surveying)
		Comparison of new and old area (comparison of the parcel area before and after surveying)

g) Survey Inspection System

– The survey inspection system is a system for checking the results of cadastral surveying by UAV and T/S. It consists of functions to perform attribute verification, file verification, attribute error correction, graph verification, overlap check and output of survey result map. The detailed functions of the survey inspection system are as follows:

[Table Ⅴ-29] Detailed Functions of the Survey Inspection System

Category	Main function	Detailed function
Basic inspection	File name	File name/format compliance
	Surveying file	Tag attributes in surveying file
	ID No.	Presence of ID number and format compliance of graphic data
		Presence of ID number and format compliance of attribute data
	Area	Tolerance (compliance with allowable error)
		Area (comparison between area based on coordinates and the map)
		Comparison of determined area (check the difference between the calculated area and the determined area)
Surveying data inspection	Attribute verification	View/select inspection file
		Check/save/print Inspection results
	File verification	View/select inspection file
		Enter basic information, control points used, and surveyor information
		Check/save/print Inspection results
	Correction of attribute error	View attribute errors
		Check/edit/save attribute errors
	Graph verification	Check/save unclosed graphs
		Check/save duplicate point errors
		Check/send inspection results
	Subdivision point verification	View/select target parcel
		Enter X, Y point number and calculate distance
		Check/save the difference between the subdivision lines
	Inspection results	Enter search conditions and check results
		Check/save appropriateness of the inspection results
	Checklist	View/check the list of inspection targets
		Select/inspect/check/save inspection items
	Past history	Enter the streets around the examined parcel
		Check/save inquiry results

Category	Main function	Detailed function
Overlap inspection	Surveying status drawing	Compare overlap between the results file and surveying file
	Cadastral layer	Compare the results file and the files used by other departments
	Aerial image	Compare the results file and aerial imagery file
Comprehensive inspection	Completion of results inspection	Final inspection of the file after results inspection
	Drawing output	Survey result map

h) Field Survey System

– The field survey system is a field surveying support program incorporated with a new technology that enables acquisition of cadastral data in the field in a quick and easy way. Its functions include real-time observation results check, image data superimposition, and survey results preparation. The detailed functions of the field survey system are as follows:

[Table Ⅴ-30] Detailed Functions of the Field Survey System

Category	Main function	Detailed function
Authentication	System authentication	Authentication processing and initialization
Login	Login	Login, Forgot Password, Request Authentication
Home	New drawing	Initialize drawing
	Import	CAD(DXF, DWG), JPG, GJN(GeoJson)
	Export	CAD, GJN(GeoJson)
	Save	Save
	Coordinates transformation	Input/transform/save transformation factor
	Background map	Import Google Map (offline)
		Import tiling images (aerial photographs and satellite imagery)
		Apply coordinate system
	Work management	Create new/Create work/Delete work
		Import/Export
	View all	View all, change background color
Field surveying	Observation	Orientation (Station point/ Backsight point / 0 setting)
		Measurement/orientation connectoin
		Range/Measurement Point/Connection
		Line of direction
		Supplementary station
		Subdivision point
		Confirmed point
	Adjustment	Key management/before alteration/after alteration/alteration results
Field surveying	Adjustment	Run/initialize
	Piling	Select/import parcel

Category	Main function	Detailed function
		Indicate distance and angle
		Install marker
Drawing editing	Edit	Symmetry / Alteration / Rotate
		Add point / Edit point / Delete piont for curved points
		Cut / Extent
		Union operation / Intersection operation / Difference operation
		Object decomposition
		Chamfer / Fillet
		Rubbersheeting
		Combining graphs
		Register/view/edit attributes
	Draw	Line/dashed line/polyline/polygon/rectangle
		Circle/arc/ellipse/spline
		Symbol, sign, number, length, character input/removal
		Create dots
	Snap	ON/OFF setting
Drawing management	Layer management	Edit, on/off, lock
	Select object	Same key/same layer/same key color/same layer color
	Style change	Character removal/symbol, line, face
	Copy	Copy/cut/delete/paste
	Screen control	View all/move/zoom in/zoom out/enlarge/reduce size
		Back/forward
		Measure length, measure area
	Object transformation	Line→Polyline, Polyline→Polygon, Polygon→Polyline
	Phase check	Setting
		Micro polygon, polygon error, duplicate parcel search
		Micro polygon, polygon error, duplicate parcel search
Detailed calculations	Control point management	View/register control points
		Azimuth and distance of known points
	Boundary point management	View/register boundary points
	Preparation of boundary point observation area	View boundary points / Boundary observation and coordinates calculation
		Manual management
		Boundary observation section output / Excel output / registration
	Boundary point calculation	Cross calculation, inverse calculation, coordinate calculation, internal angle calculation, line partition
Detailed calculations	Intersection calculation	Rear 2 points, rear angle
	Subdivision	Subdivision of 1 parcel / Serial subdivisions

Category	Main function	Detailed function
	Preparation of observation records	
	Boundary point connection	
	Results preparation	
	Fine adjustment of boundaries	
Settings	Basic settings	Survey team management, route, decimal point settings
	Observation equipment	View observation equipment list / Add equipment
		Surveying origin settings

i) Image Basemap Management System

– The image basemap management system integrates satellite image, aerial and drone photos by region and shooting date. It creates image indexes and meta information so that users can conveniently search for the desired image. It is possible to check the video screen in 2 or 4 divisions to analyze the video of time series. The detailed functions of the image basemap management system are as follows:

[Table Ⅴ-31] Detailed Functions of the Image Basemap Management System

Category	Main function	Detailed function
Image data management	Import image	Import images
		Input, edit, delete metadata
		Create index layer
	Searching image	Searching date
		Searching administrative area
		Searching satellite image, aerial & drone image
		Searching index
		Searching area by user
	Delete image	Delete image data / index
Image data analysis	Time series analysis and multiscreen	Image data time series analysis
		Display multiscreen(2, 4 division)
Image data print-out	Export	Save image data to user PC
	Pint-out	Preview and print-out
	Tiling image generation	Set option for tiling image
		Display status of tiling process
		Save tiling image

4.3.2.Land Information Service System

❍ The land information service system (LISS) provides services for general citizens to conven iently check cadastral maps and information on land such as state-owned lands and private l ands on the Internet based on superimposed cadastral satellite images via the Internet anyti me, anywhere.

❍ The main detailed functions of LISS are as follows:

[Table Ⅴ-32] Detailed Functions of the Land Information Service System

Category	Main function	Detailed function
Map screen	View map	Zoom in, zoom out and pan on the map
		View address
		Display legend
	Measurement	Measure distance, measure area
	Layer settings	Cadastral map, road, building layer on/off
		Aerial photograph on/off
Land information	Information search	Location search
		Land owner, price information
		Land price information
		Information on state-owned lands and private lands
		land use information
Announcements	Information provision	Provide gazette, law & regulation information
	Notice	Searching notice
	Check status	Check application status
	Bulletin	Search, input, edit, delete bulletin board
Data sharing	Data connection	Information list API service
		Information search API service
	Connection management	Management of organization of data connection and connection status
	Location sharing	Connection of URL of map location

4.4.System Development Plan

- For land information system development, open source-based programs will be developed to minimize the distribution and maintenance costs, while in the case of the database manage ment system, Oracle DMBS will be applied in consideration of compatibility with the SDS L database. Application of the agile methodology is recommended in consideration of the n ature of the project, which involves carrying out development in remote areas

- System is developed in cooperation with local private companies to secure the foundation f or maintenance and foster private experts in the future. Plan to put into test operation

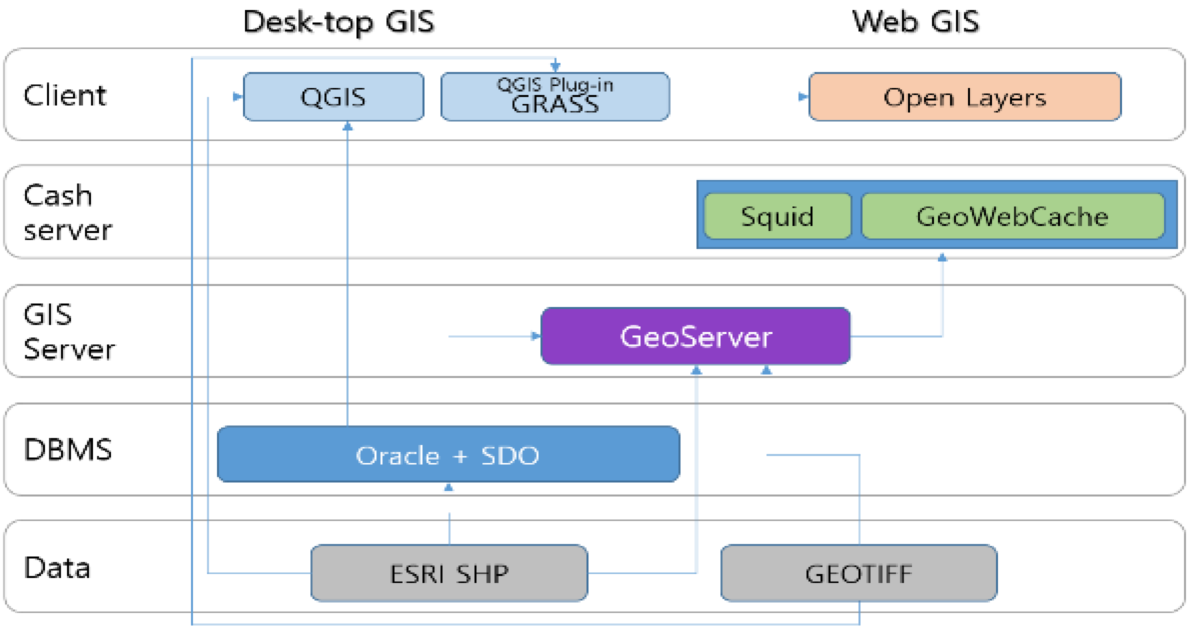
- The system is developed in Sinhalese, Tamil, and English versions, the Main contractor is i n charge of the English version, and the local developers support the development of Sinhal ese and Tamil versions

- Prevents security risks and increases user convenience by applying a Single Sign On (SSO) service that allows access to multiple systems with only one account without having to go through the authentication process for each system

- Investigation and analysis for system development are carried out locally within 4 months a fter the start of the main project, and system development is carried out in collaboration wit h the contractor and the OJT staff in SDSL

4.4.1.Open Source

❍ The development of open source-based programs can prevent dependence on specific syste ms and ensure efficient maintenance and repair. It can also bring the effect of spreading op en source solutions centering on the public sector.



[Figure Ⅴ-27] Example of Open Source-Based System Architecture

❍ An open source-based open source is a generic term referring to resources that are in comp liance with open source license in that the source code can be modified and redistributed b y anyone while protecting the rights of the software or hardware producer. when the origina l producer "opens" the data, software source code, and drawings of the hardware production method, users can download them and modify them for redistribution ("participate"), thereb y creating new value in the process.

❍ Various open sources ranging from data to software and hardware are being released in a b roader scope, and through system development centering on open software that is widely us ed and verified in open source fields, it is possible to reduce maintenance and repair costs after project completion and minimize technical reliance on certain companies.

❍ Open source-based spatial information software and library

[Table Ⅴ-33] Open Source Spatial Information Software and Library

Type	Open sources
Software	QGIS, uDIG, OpenLayers, Map Window, WorldWind
Spatial information management server	GeoServer
Library	GDAL/OGR, GeoTools

4.4.2.Database Management System (DBMS)

❍ The most popular commercial DBMS for spatial information-based systems is Oracle, and PostgreSQL is widely used for open source DBMS.

❍ Oracle has been selected for the DBMS in consideration of the stability of the Oracle database and its compatibility with the existing SDSL system.

[Table Ⅴ-34] Comparison of DBMS

Category	Oracle	PostgreSQL
Characteristics	• Database license can be freely used anywhere on Cloud and on the premises • No. 1 global market share among commercial DBMS • Centralized system that allows for administration monitoring and tuning of multiple databases	• Employs a adaptation architecture where old data are left when updating or deleting data and new data are added at the end. • Implementation of transaction attribute ACID (atomicity, consistency, isolation, durability) • Encryption of data transmitted between client and network through SSL communication and host-based access control
Pros	• Excellent for handling large amounts of data • Can design the database considering performance apart from the hardware	• Freedom of redistribution of edited source of BSD license • Reduced licensing costs resulting from system expansion
Cons	• License fee • Relatively many items that the DBA needs to set for system tuning	• Difficulty in receiving maintenance services • Lack of flexibility due to strict SQL standards • Learning costs incurring from insufficient user base
Choice	○	

4.4.3.Development Methodology

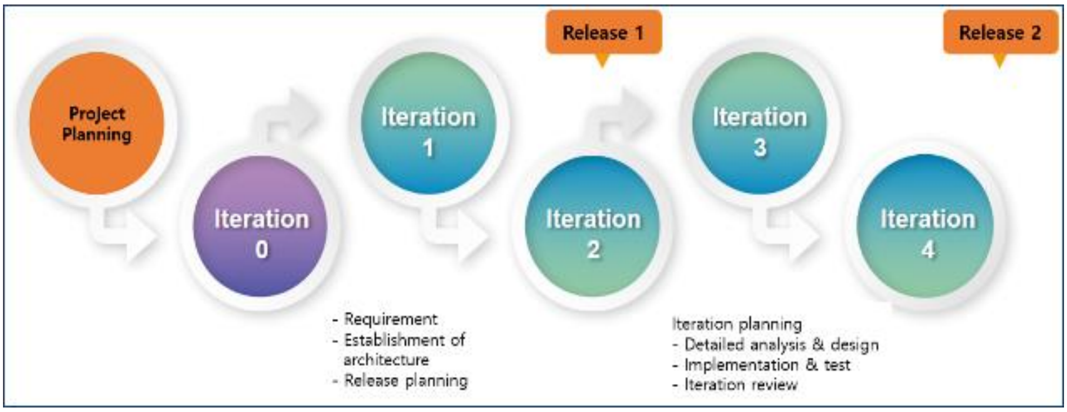
❍ In the case of large-scale system development such as land information system, due to the complexity of the process, problems such as low reliability of S/W, increased development cost, and delayed development plan frequently occur. In order to solve these problems, various methodologies have been developed that apply the Software Development Life Cycle(SDLC). We propose a new approach called ‘Agile methodology’, which is widely used for large scale remote system development.

❍ It is necessary to have an infrastructure environment that can share the development requirements in consideration of the characteristics of projects that are developed remotely and introduce a system to mutually recognize the development results from the analysis and design stages for accurate definition and demand analysis of Sri Lankan land work

❍ Agile methodology began as a way to solve the problems of traditional software development, and aims to prioritize the functions that are valuable to customers while minimizing the uncertainty of requirements and to minimize frequent communication and output with custo mers

[Table Ⅴ-35] Comparison of S/W development methodology

Category	Water fall(traditional)	Agile
Oriented (plan VS customer)	• Develop a schedule for the entire project period before starting the project and proceed with the project accordingly	• Rather than creating unreasonable or unrealistic plans, the plan focuses on what is important or confirmed to the customer at this time and recognizes that the plan can be changed according to the project situation. • Principles develop the features that customers value first
Release (big bang VS small)	• Release all features at once at the end of the project	• Repeat small releases over a period of time called iteration • Customers check early to see if requirements are being reflected
Focus (output VS S/W)	• Ensure that the project is going well by checking whether the deliverables have been created at the planned stages	• It is important that the software works properly and how well it is designed to meet the requirements • More flexible meaning that the output can be produced in various forms to suit the situation, rather than not creating a document
Choice		○



[Figure Ⅴ-28] Form of Agile Development Methodologies

4.4.4.Data security

❍ Open source software is known to be susceptible to hacker attacks because of its open sour ce, but that's not true. Today's state of the art security has little to do with whether the sou rce is public or not, and open source software quickly patches or upgrades within hours or days after discovering a flaw such as security vulnerability, while the source is proprietary. In-software users will be forced to rely on vendors until software vendors release upgraded binary versions, requiring considerable time, while users are vulnerable to known threats

❍ In order to support security issues related to data processing and communication, several pr ojects based on open source software have been developed and provided with reliable encry ption technology for the public sector. Provides management solution for application progra m and used key for encryption using hardware encryption function

❍ The DB encryption configuration method supports personal information protection, prevents data leakage, and proposes an API method with no load on the DBMS

[Table Ⅴ-36] Comparison of DB encryption type

Items	Oracle TDE (Transparent Data Encryption)	API
Encryption method	Encryption by DBMS kernel	Calling encryption/decryption by API server
Load on DB server	With load when encryption/decryption	Without load to DBMS
Security for personnel information	△	O
Using Algorithm	AES, 3DES	AES, 3DES, SEED, ARIA, SHA-256/384/512
Management of Key and policy	Saving in DB server(possible to save separated key server)	Saving separated key server
Security inspection	No function of saving	Saving access record of encryption column and change of policy
Authorization management	No function of authorization management	Separated authority of DB manager and DB security manager(value: account/IP/Mac/App name/time/period/date)
Maintaining encryption	Maintaining encryption when saving in data file	Maintaining in table/index/each DB/ Log/SGA(memory)
Environment change of DBMS when installation	X	No change
Change of existing application	No changes	Need to edit various application
Possibility of data leakage	Possible to data-leak for no decryption control function after DB log-in	Possible to data-leak to unauthorized person
Performance(respo nse speed) gap(before, after encryption)	No gap	Barely gap
Choice		O

5.Construction Plan for Data Center and Infrastructure

5.1.Specifications and Details of the Introduced Equipment

5.1.1.Main Data Center

❍ Equipment composing the main data center of the Sri Lanka LIS is as follows:

[Table Ⅴ-37] Main Data Center Specifications and Details of the Introduced Equipment

Category	Equipment	Specification	Quantity	Remarks
Servers	DMZ - Public Service WEB/WAS Server	CPU3.6GHz4Core*2EA Memory:64GBHDD600GB10KSASx2EA	1	
	DMZ - Government Service WEB/WAS Server	CPU3.6GHz4Core*2EA Memory:64GBHDD600GB10KSASx2EA	1	
	LAS - WEB/WAS/SSO Server	CPU3.6GHz4Core*2EA Memory:32GBHDD600GB10KSASx2EA Dualport16GbpsHBA*1EA	1	
	LISS - WEB/WAS/SSO Server	CPU3.6GHz4Core*2EA Memory:32GBHDD600GB10KSASx2EA Dualport16GbpsHBA*1EA	2	
	DB Server	CPU3.6GHz4Core*2EA Memory:32GBHDD600GB10KSASx2EA Dualport16GbpsHBA*1EA	2	
	Cluster Solution (HA)	StorageSharing&DBPostgreSQL	1	
	GIS Server	CPU2.6GHz4Core*2EA Memory:16GBHDD600GB10KSASx2EA Dualport16GbpsHBA*1EA	2	
	Backup Server	CPU2.6GHz4Core*2EA Memory:16GBHDD600GB10KSASx2EA Dualport16GbpsHBA*1EA	2	
	Data Connection Server	CPU2.6GHz4Core*2EA Memory:16GBHDD600GB10KSASx2EA Dualport16GbpsHBA*1EA	2	
	WEB/WAS Development Server	CPU2.6GHz4Core*2EA Memory:16GBHDD600GB10KSASx2EA Dualport16GbpsHBA*1EA	1	
	Development DB Server	CPU3.6GHz4Core*2EA Memory:32GBHDD600GB10KSASx2EA Dualport16GbpsHBA*1EA	1	
	KVM S/W	19-inch, 16-port PS/2-USB	1	
Storage	SAN Switch	16-port SAN Switch include GBIC 16EA	2	

Category	Equipment	Specification	Quantity	Remarks
and Backup	Storage #1 (LAS)	Dual Controller, 128GB Cache, 32G FC 8Port 10Krim 12G SAS Disk, Usable 157 TB	1	
	Storage #2 (LISS)	Dual Controller, 128GB Cache, 32G FC 8Port 10Krim 12G SAS Disk, Usable 50 TB	1	
	VTL (Virtual Tape Library)	32G FC 2Port(Min) Usable 105 TB	1	
Network	Backbone Switch	Switch Capacity 2Taps or higher 10/100/1000 * 48Port or higher, 1G SF * 24Port or higher	2	
	L2 Switch	10/100/1000 * 24Port, 2SF or higher	4	
	L4 Switch	L4/7 Throughput: 2Gaps, 1G SF * 8port & 10/100/1000BASE-T 12Ports & 1G/10G * 2port	6	
Security System	DDoS	Max performance: 8Gaps, support power supply redundancy 8*10/100/1000B-TX, 2*1000B-SS, 0*10GB-X	2	
	IPS	Incl. IPS License, power supply redundancy 8*10/100/1000B-TX, 8*1000B-SS 10G Base-X x 0	2	
	Main Firewall	Firewall Throughput: 16Gaps or higher, power supply redundancy 8*10/100/1000B-TX/ 8*1000B-SS 10G Base-X x 0	2	
	Server Farm Firewall	Throughput: 8Gbps or higher, power supply redundancy 8*10/100/1000B-TX/ 8*1000B-SX	2	
	Web Firewall	Throughput: 600Mbps, power supply redundancy Port: 8 x 1G SFP, 8 x 1G Copper	2	
	NMS/SMS/FMS	Integrated management of failure events, server performance, failure management, Network equipment management, management of auxiliary equipment in computer room	1	
	Access Control	System access and authorization authentication, system connection session control Server License 10ea, Network License 15ea	1	
	ESM	Unstructured log collection and log parsing automation, real-time monitoring, log search, critical point analysis	1	
	NDVR	Full HD 1080P, 8ch, Supports up to 8Mega pixel esolution, 10TB HDD	1	

5.1.2.Backup Data Center

- ❍ The equipment for hot site construction for the Sri Lanka LIS are as follows.
- ❍ SLT IDC facilities will be utilized as power and air conditioning facilities for system operatio n.
- ❍ Install independent fence to reinforce security in the server room

[Table Ⅴ-38] Backup Data Center Specifications and Details of the Introduced Equipment

Category	Equipment	Specification	Quantity	Remarks
Servers	DMZ - public serviceWEB/WAS Server	CPU3.6GHz4Core*2EA Memory:64GBHDD600GB10KSASx2EA	1	
	DMZ - government service WEB/WAS Server	CPU3.6GHz4Core*2EA Memory:64GBHDD600GB10KSASx2EA	1	
	LAS - WEB/WAS/SSO Server	CPU3.6GHz4Core*2EA Memory:32GBHDD600GB10KSASx2EA Dualport16GbpsHBA*1EA	1	
	LISS - WEB/WAS/SSO Server	CPU3.6GHz4Core*2EA Memory:32GBHDD600GB10KSASx2EA Dualport16GbpsHBA*1EA	2	
	DB Server	CPU3.6GHz4Core*2EA Memory:32GBHDD600GB10KSASx2EA Dualport16GbpsHBA*1EA	2	
	Cluster Solution(HA)	StorageSharing&DBPostgreSQL	1	
	GIS Server	CPU2.6GHz4Core*2EA Memory:16GBHDD600GB10KSASx2EA Dualport16GbpsHBA*1EA	2	
	Backup Server	CPU2.6GHz4Core*2EA Memory:16GBHDD600GB10KSASx2EA Dualport16GbpsHBA*1EA	2	
	Data Connection Server	CPU2.6GHz4Core*2EA Memory:16GBHDD600GB10KSASx2EA Dualport16GbpsHBA*1EA	2	
	KVM S/W	19-inch, 16-port PS/2-USB	1	
Storage and Backup	SAN Switch	16-port SAN Switch include GBIC 16EA	4	
	Storage #1 (LAS)	Dual Controller, 128GB Cache, 32G FC 8Port 10Krim 12G SAS Disk, Usable 157 TB	1	
	Storage #2 (LISS)	Dual Controller, 128GB Cache, 32G FC 8Port 10Krim 12G SAS Disk, Usable 50 TB	1	

Category	Equipment	Specification	Quantity	Remarks
	VTL (Virtual Tape Library)	32G FC 2Port(Min) Usable 105 TB	1	
Network	Backbone Switch	Switch Capacity 2Tbps or higher 10/100/1000 * 48Port or higher, 1G SFP * 24Port or higher	2	
	L2 Switch	10/100/1000 * 24Port, 2SFP or higher	4	
	L4 Switch	L4/7 Throughput: 2Gbps, 1G SFP * 8port & 10/100/1000BASE-T 12Ports & 1G/10G * 2port	6	
Security System	DDoS	Max performance: 8Gbps, support power supply redundancy 8*10/100/1000B-TX, 2*1000B-SX, 0*10GB-X	2	
	IPS	Incl. IPS License, power supply redundancy 8*10/100/1000B-TX, 8*1000B-SX 10G Base-X x 0	2	
	Main Firewall	Firewall Throughput: 16Gbps or higher, power supply redundancy 8*10/100/1000B-TX/ 8*1000B-SX 10G Base-X x 0	2	
	Server Farm Firewall	Throughput: 8Gbps or higher, power supply redundancy 8*10/100/1000B-TX/ 8*1000B-SX	2	
	Web Firewall	Throughput: 600Mbps, power supply redundancy Port: 8 x 1G SFP , 8 x 1G Copper	2	
	NMS/SMS/FMS	Integrated management of failure events, server performance, failure management, Network equipment management, management of auxiliary equipment in computer room	1	
	Access Control	System access and authorization authentication, system connection session control Server License 10ea, Network License 15ea	1	
	ESM	Unstructured log collection and log parsing automation, real-time monitoring, log search, critical point analysis	1	

5.1.3.District Survey Offices

❍ Equipment for improving the working environment of individual district survey offices (25 l ocations) of the Sri Lanka LIS are as follows:

[Table Ⅴ-39] District Survey Offices Specifications and Details of the Introduced Equipment

Category	Equipment	Specification	Quantity	Power consumption(W)	
Introduced	L2 Switch	10/100/1000 * 24Port, 2SFP or higher	1	30	60

Category	Equipment	Specification	Quantity	Power consumption(W)	
equipment	Patch Panel	RJ-45, 24 Port	2	-	-
	Workstation	CPU: 3.6GHz 4Core * 2ea Mem: 32GB, HDD: 600GB 10K SAS * 2ea Graphic: Radeon Pro or higher	2	450	900
	NAS Storage (Physical 10 TB)	Quad-Core Processor / DDR4 2GB / 10/100/1000 Mbps (Fast-Ethernet)/ Hot Swappable / 1U Rack Mountable	1	250	250
	Scanner	ADF and Flatbed Scanner 1,200 DPI x 1,200 DPI (Hor. x Ver.) Scanning Speed: Mono/Color - 25 p/min	1	50	50
	UPS	2U, 1.5 kVA or higher. RACK Mountable	1	-	-
Equipment introduced into district survey offices (total)				1260 W	
Laying of UTP cable and installation of exposed outlets for Intranet (15 locations) set of rack for additional equipment (incl. power distribution unit)					

5.1.4.Divisional Survey Offices

❍ The equipment for implementing an integrated network environment of individual divisional survey offices (84 locations) of the Sri Lanka LIS are as follows:

[Table Ⅴ-40] Divisional Survey Offices Specifications and Details of the Introduced Equipment

Category	Equipment	Specification	Quantity	Power consumption(W)	
Introduced equipment	F/O Patch Panel	16 Port or higher, pig tail & FC Connector	1	-	-
	LGN Router	10/100/1000 * 24Port, 2SFP or higher	1	75	75
	Firewall	Checkpoint CP 3200	1	60	60
	L2 Switch	10/100/1000 * 24Port, 2SFP or higher	1	30	30
	Patch Panel	RJ-45, 24 Port	2	-	-
	UPS	2U, 1 kVA or higher. RACK Mountable	1	-	-
Equipment introduced into divisional survey offices (total)				165W	
Laying of UTP cable and installation of exposed outlets for Intranet (2 locations) 1 set of rack for additional equipment (incl. power distribution unit)					

5.1.5.Local Authority(Municipal Council)

❍ The LAS User PC(including LAS Client Software), which is newly supplied to the Local Authority (Municipal Council), automatically displays the LAS UI (User Interface) after booti ng through PC configuration, allowing MC personnel to use LAS Log-in and services without any additional process.

- ❍ LGN 2.0 Service is not currently available to all local authorities, but LGII's annual supply expansion plan has confirmed that the service will be provided within the next three years.
- ❍ Separately, the newly installed LAS is a WEB Based Application, and it is confirmed that there is no problem in accessing and using the service to each Municipal Council that currently uses the SLT lease network.
- ❍ Equipment for improving the working environment of individual municipal council (24 locations) of the Sri Lanka LIS are as follows

[Table Ⅴ-41] Municipal Council Specifications and Details of the Introduced Equipment

Category	Equipment	Specification	Unit Q'ty	**Total Q'ty**
Introduced equipment	LAS User PC(including LAS Client Software)	CPU : Intel Core i7-8700 (3.2GHz, 6Core) Mem : 8GB HDD : SSD M.2 256GB * 1EA, SATA 7.2Krpm 1TB * 1EA, O/S : Windows10 Pro 64bit Keyboard, Mouse, 24" LCD Monitor	2 set	48 set

5.2.Construction Plan for Data Centers

5.2.1.Selection of Project Areas

- ❍ The headquarters of the Survey Department of Sri Lanka (SDSL) operating under the Ministry of Lands and Parliamentary Reforms (MoLPR) is located in Colombo, the political and economic capital of Sri Lanka, and it is a three-story building located about an hour drive away from Bandaranaike International Airport (32km in straight line).
- ❍ In Sri Lanka, infrastructure environment and service stability vary widely by region, and Western Province, where the capital is located, has a significantly lower frequency of electricity supply and other communication services than other regions.
- ❍ It is located 7.5km straight from the Port of Colombo containing a terminal which handles 2.4 million TEU or around 5 million containers measuring 20 feet (TEU) each year, and thus it has excellent accessibility to shipped cargo.
- ❍ The average monthly temperature in Colombo is 27.3~29.4℃ and the annual precipitation is about 1,990mm, which is relatively lower than the central region (at least 5,000mm annually) where flood damage occurs every year.
- ❍ The Second(2nd) Floor of the SDSL HQ is the space for the main equipment and network links of the land information system (LIS) currently in operation as well as the operators thereof. Therefore, it will facilitate the operation, maintenance and repair of LAS and LISS to be set up in the future.
- ❍ In addition, failure or interruption of the system (survey data computerized management sys

tem) in operation due to infrastructure / environmental facilities was not confirmed during t he course of this task during the field survey and interviews with the personnel in charge.

- Main Data Center located No 150, Kirula Road, Narahenpita, Colombo 05 at SDSL 2nd floor, Backup Center located Techno City, Pitipana, Homagama, 20km from the Survey Department HQ

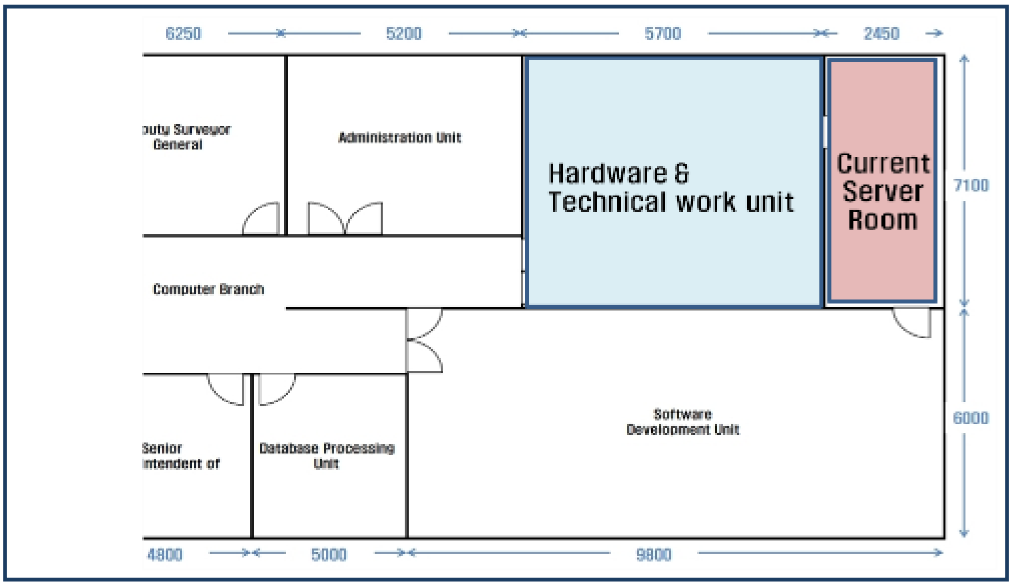
[Figure Ⅴ-29] Location of Main Data Center & Backup Data Center

5.2.2.Space Utilization Plan for Data Center

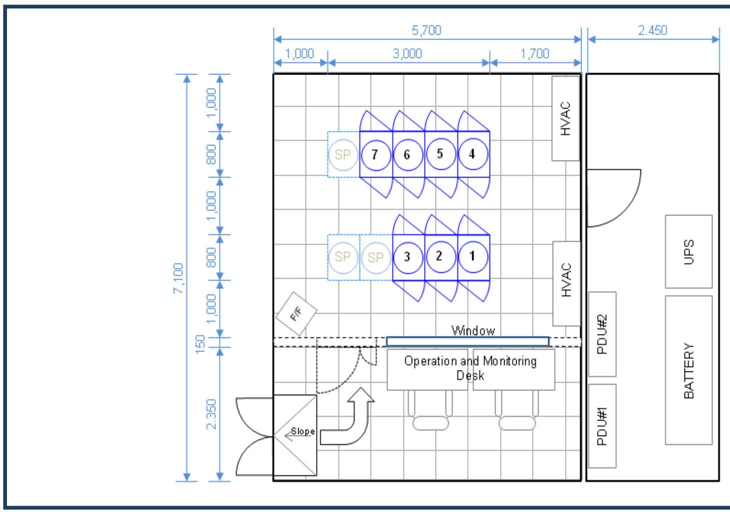
- There are currently two racks (one for the network and one for the servers) in the current s erver room, and there are two air conditioners (A/Cs) being operated in an alternating mann er.
- If the same site is used, it will be inevitable to suspend equipment operation in order to car ry out environmental construction, and four additional racks need to be installed to set up t he new system, but there are insufficient surfaces for such installations.
- In addition, there is a high risk of leakage due to drainage piping for rainwater that penetra tes through the room.
- For the above reasons, it has been agreed to instead use the space on the side of the existin g server room (currently the workspace for the O&M personnel).
- It is possible to install the racks as two-tier racks and to secure a space for three additional racks in the future.
- It is possible to secure a space for operation and monitoring in front of the equipment roo m for efficient operation.
- In order to provide more effective DC space, this feasibility study reviewed the containerize

d data center in the early stage of the task, but utilized the space in the building proposed by the source organization in consideration of the accessibility of the operation personnel an d the installation area of the new device.

❍ Supplementing the incidental environmental facilities (regular power supply, emergency pow er supply and redundant thermo-hygrostat) have been considered to minimize risks.



[Figure Ⅴ-30] Target Spaces in the Data Center



No.	Description
1	Network #1 & MDF
2	Network #2
3	Miscellaneous NMS/SMS/EMS
4	DB Server
5	WEB/WAS Server
6	Storage
7	ACS & CCTV
SP	Space for Future use

[Figure Ⅴ-31] Utilization Plan for the Spaces in the Data Center

5.2.3.Hardware/Software/Network Construction Plan

1) Server and Storage Construction Plan

❍ When calculating the server capacity for the SDSD land data system server and storage, the standard that was applied was "A Guideline for Hardware Sizing of Information Systems (December 19, 2018)" of the Telecommunications Technology Association (TTA) of Korea.

❍ The TTA Guideline suggests that 1% to 10% of all users be counted as connected users and 5% to 10% of the connected users be counted as concurrent users for systems with a large number of unspecified users such as a civic portal.

❍ Considering the number of land information system users and transaction processing capacity (tpmC), servers that can be scaled in the future as a way to prepare for an increase in the number of users and that the recipient country can easily repair troubleshoot were chosen.

❍ The calculation basis according to the purpose of use for each server as well as the CPU, memory, and hard disk capacity are as shown in the table below.

❍ Basis and capacity of CPU selection

– WEB/WAS servers

[Table Ⅴ-42] Basis for WEB/WAS CPU Calculations

No.	Item	Description	General value
1	Number of concurrent users	26.69 million (total population) x Internet usage rate (32.05%) x Connected users (1%) x Concurrent users (5%) = 3,476 (external access) 610,000 people (number of stakeholders[30]) x Internet usage rate (32.05%) x Rate of connected users (1%) x Average number of concurrent users (5%) = 99 people Internal server: 99 people / Public service server: 3,476 people Concurrent users x Annual growth rate of 30% (3 years)	218 / 7,637
2	Operation number per user	Apply 5, even though the web service and application logic are mixed, because it mainly handles web service operations	5
3	Basic OPS correction	Correction performed to apply OPS values measured in an experimental environment to a complex real-life environment	3
4	Correction according to purpose of use	Apply 2 by calculating the correction value according to the type of system in question based on WAS server	2
5	Interface load correction	Apply the load factor occurring on the interface during communication with other servers	1.1
6	Peak time load correction	Apply 30% as the load factor to prevent load caused by a rise in connected users	1.3
7	System redundancy	Apply 30% as the correction value for stable system operation as the level of importance and urgency of the work is high	1.3
8	System target utilization rate	Apply 0.7 as the CPU utilization rate under the assumption that the system is operating stably	0.7

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No.	Item	Description	General value
Equation	OPS = (number of concurrent users * number of operations per user * basic OPS correction * correction according to purpose of use * interface load correction * peak time load correction * system redundancy) / system target utilization rate When using Web/WAS servers simultaneously, the final value is obtained by multiplying the estimated value by 1.6		

Source: TTA

– General servers (GIS, data linking and backup server)

[Table Ⅴ-43] Basis for General Server CPU Calculations

No.	Item	Description	General value
1	Number of concurrent users	1.12 million (total number of public servants[31]) x Internet usage rate (32.05%)x Connected users (1%) x Concurrent users (5%) = 179 people Concurrent users x Annual growth rate of 30% (3 years)	394
2	Operation number per user	Apply 5, even though the web service and application logic are mixed, because it mainly handles web service operations	5
3	Basic OPS correction	Correction performed to apply OPS values measured in an experimental environment to a complex real-life environment	3
4	Correction according to purpose of use	Apply 2 by calculating the correction value according to the type of system in question based on WAS server	2
5	Interface load correction	Apply the load factor occurring on the interface during communication with other servers	1.1
6	Peak time load correction	Apply 30% as the load factor to prevent load caused by a rise in connected users	1.3
7	System redundancy	Apply 30% as the correction value for stable system operation as the level of importance and urgency of the work is high	1.3
8	System target utilization rate	Apply 0.7 as the CPU utilization rate under the assumption that the system is operating stably	0.7
Equation	OPS = (number of concurrent users * number of operations per user * basic OPS correction * correction according to purpose of use * interface load correction * peak time load correction * system redundancy) / system target utilization rate When using Web/WAS servers simultaneously, the final value is obtained by multiplying the estimated value by 1.6		

Source: TTA

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– DB Server

[Table Ⅴ-44] Basis for Database Server CPU Calculations

No.	Item	Description	General value
1	Number of concurrent users	1.12 million (total number of public servants) x Internet usage rate (32.05%) x Connected users (1%) x Concurrent users (5%) = 179 people Concurrent users x Annual growth rate of 30% (3 years)	394
2	Number of transactions per minute	Number of current users, operation number per user(2~7) and number of transactions per operation (4~6) (number of operation: 2, transaction: 4)	3,940
3	Basic tpmC correction	Correction performed to apply the value measured in an experimental environment to a complex real-life environment	5
4	Peak time load correction	Correction made to ensure smooth system operation during the peak time	1.3
5	Database size correction (apply for database server)	Considers the number of database table records and the total database volume	1.7
6	Application architecture correction	Considers the application architecture and the performance gap due to the required response time	1.2
7	Application load correction	Considers simultaneous assignments at the peak time for online work	1.7
8	Cluster correction	Correction made in preparation for failures in a cluster environment	1.5
9	System redundancy	Correction made to ensure stable system operation	1.3
10	System target utilization rate	CPU utilization rate determined under the assumption that the system is operating stably	0.7
Equation	tpmC = (number of concurrent users * number of transactions per minute * basic tpmC correction * peak time load correction * database size correction * application architecture correction * application load correction * cluster correction * system redundancy) / system target utilization rate		

Source: TTA

– Memory Calculation Basis and Services

[Table Ⅴ-45] Memory Calculation Method

No.	Item	Description	General value
1	System area	Default OS + service + other utilities	6,144
2	Required memory per user	Memory per user necessary for application, middleware and DBMS use	2
3	Number of concurrent users	Number of concurrent users * Rate of increase: 30% * 3 years	Corresponding value

No.	Item	Description	General value
4	OS buffer cache correction	Correction of memory location where a certain amount of data is stored temporarily in order to improve the processing speed	1.15
5	Middleware buffer cache memory	Cache area used by middleware such as heap size in WAS and shared memory in DBMS	2
6	System redundancy	Correction for stable system operation	1.3
Equation	Memory (MB) = {system area + (required memory per user * number of users) + middleware buffer cache memory} * OS buffer cache correction *system redundancy		

Source: TTA

– Basis for Disk Capacity Calculations

[Table Ⅴ-46] Disk Calculation Method

No.	Item	Description	General value
1	System OS area	Windows Server, Service	32,768
2	Application program area	Middleware and application software areas, databases, and other utility installation areas	31,232
3	SWAP area	Workspace for performing dumping role in case of system failure and swapping memory	32,768
4	File system overhead	A space for managing super users for the user management area and a space for managing files such as I-node Overhead	1.1
5	Spare for System Disk	A correction value necessary for stable system operation; apply the general value taking into consideration the level of importance or urgency of the operation	1.3
6	Space for RAID configuration	RAID 1: 100%, RAID 5: 30%	2
Equation	System disk = (system OS area + application software area + SWAP area) * file system overhead * Spare area for System Disk * Space for RAID configuration		

Source: TTA

❍ Sizing calculation results and recommended specifications for general servers, Web/WAS servers, and DB servers to be set up at the Sri Lanka LIS main data center are as follows:

[Table Ⅴ-47] Final Size Calculation Results

Category	Calculation item	General server	Web/WAS serve		DB server
			Internal	Public service	

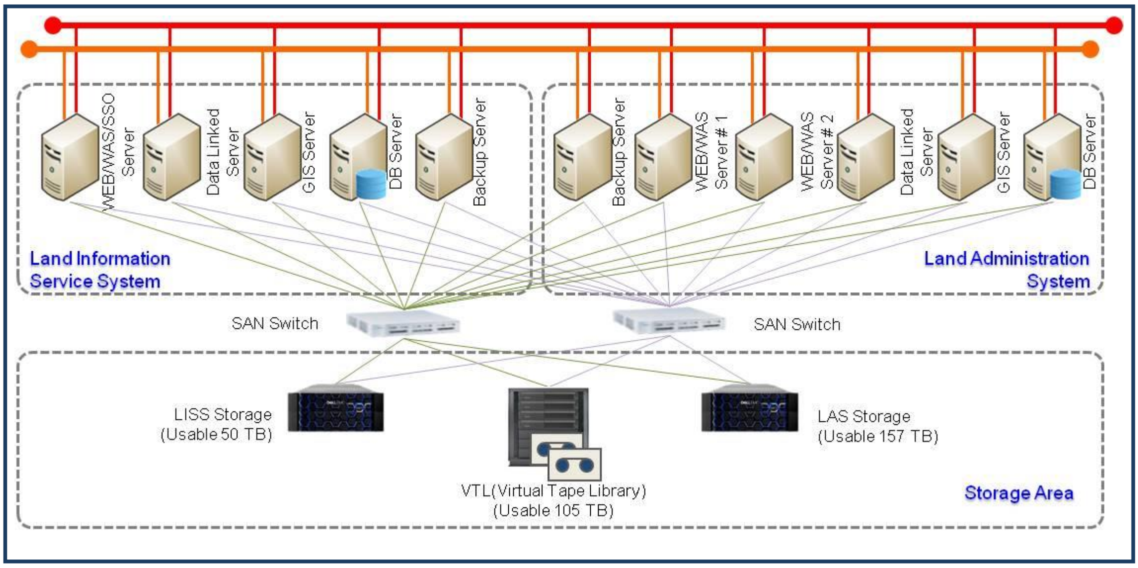
Category	Calculation item	General server	Web/WAS serve		DB server
			Internal	Public service	
Calculation results	CPU (tpmC)	24,564	13,586	477,011	246,952
	Memory (GB)	10.37	9.84	32.03	8.24
	Disk (GB)	277	277		277
Recommended spec.	CPU (minimum requirement)	2.0Ghz 4Core 2P	2.0Ghz 4Core 2P	3.6Ghz 4Core 2P	3.0Ghz 4Core 2P
	Memory (GB) (minimum requirement)	16	16	64	16
	Disk (GB) (minimum requirement)	300*2 (Raid1+0)	300*2 (Raid1+0)		300*2 (Raid1+0)

❍ Storage Architecture Plan

– As for the data storage measures for the Sri Lanka LIS, they will be largely divided into a service data area through the disk array using SCSI interface and a management data area using Virtual Tape Library (VTL) in the method of SAS or SATA interface in order to consider the economic impacts of securing a large-scale storage space.

– The service data area physically separates the land administration system (LAS) and the land information service system (LISS).

– The disk array and VTL are connected to the SAN switch which is redundant with the upper server farm in order to ensure stability and data input/output speed.



[Figure Ⅴ-32] Storage Area Composition

– The data volume generated following the establishment of the Sri Lanka LIS and the storage size for each purpose are as follows:

[Table Ⅴ-48] Cadastral Size for Each District Survey Office

Provinces	District Name	Area of DB (㎢)	Cadastral Size (789 byte/㎡)	Remarks
Western Province	Kalutara	1,574	1.26 TB	
	Colombo	676	0.54 TB	
	Gampaha	1,341	1.07 TB	
North-Western Province	Kurunegala	4,621	3.69 TB	
	Puttalam	2,876	2.29 TB	
North Province	Jaffna	938	0.75 TB	
	Vavuniya	1,861	1.48 TB	
	Mannar	1,881	1.50 TB	
	Mulativu	2,412	1.92 TB	
	Kilinichchi	1,204	0.96 TB	
Central Province	Kandy	1,915	1.53 TB	
	Matale	1,951	1.56 TB	
	Nuwaraeliya	1,704	1.36 TB	
North-Central Province	Anuradapura	6,659	5.31 TB	
	Polonnaruwa	3,078	2.45 TB	
Eastern Province	Trincomalee	2,525	2.01 TB	
	Batticaloa	2,609	2.08 TB	
	Ampara	4,228	3.37 TB	
Southern Province	Galle	1,620	1.29 TB	
	Matara	1,267	1.01 TB	
	Hambantota	2,496	1.99 TB	
Sabaragamuwa Province	Kegalla	1,688	1.35 TB	
	Ratnapura	3,237	2.58 TB	
UVA Province	Badulia	2,823	2.25 TB	
	Monaragala	5,511	4.39 TB	

Provinces	District Name	Area of DB (㎢)	Cadastral Size (789 byte/㎡)	Remarks
TOTAL		**62,695 ㎢**	**49.99 TB**	

[Table Ⅴ-49] UAV Image Size (24 Municipal Councils)

Municipal Council (MC)	Extents (㎢)	Capacity(TB)		
		Management Ingae		Service Image
		Raw UAV Image (101.7KB/㎡)	UAV Ortho-Image (33.9KB/㎡)	Ortho-Image Tiling Data (135.6KB/㎡)
Colombo	40.33	4.10	1.36	5.46
Dehiwala-Mount	21.07	2.14	0.71	2.85
Kaduwela	88.11	8.96	2.98	11.94
Moratuwa	19.26	1.95	0.65	2.6
Sri Jayawardanapura Kotte	16.47	1.67	0.55	2.22
Gampaha	27.81	2.82	0.94	3.76
Negombo	28.53	2.90	0.96	3.86
Kurunegala	11.80	1.19	0.39	1.58
Jaffna	19.49	1.98	0.66	2.64
Kandy	27.01	2.74	0.91	3.65
Dambulla	57.05	5.80	1.93	7.73
Matale	12.16	1.23	0.41	1.64
Nuwaraeliya	13.55	1.37	0.45	1.82
Anuradapura	46.99	4.77	1.59	6.36
Polonnaruwa	38.14	3.87	1.29	5.16
Baticaloa	38.10	3.87	1.29	5.16
Akkaraipattu	5.39	0.54	0.18	0.72
Kalmunai	28.53	2.90	0.96	3.86
Galle	18.70	1.90	0.63	2.53
Matara	21.02	2.13	0.71	2.84
Hambantota	82.78	8.41	2.80	11.21

Municipal Council (MC)	Extents (㎢)	Capacity(TB)		
		Management Ingae		Service Image
		Raw UAV Image (101.7KB/㎡)	UAV Ortho-Image (33.9KB/㎡)	Ortho-Image Tiling Data (135.6KB/㎡)
Rathapura	26.37	2.68	0.89	3.57
Badulla	10.61	1.07	0.35	1.42
Bandarawela	8.75	0.88	0.29	1.17
Total		71.87 TB	23.88 TB	94.58 TB

[Table Ⅴ-50] Satellite Image Size

No.	Category (purpose of use)	Capacity	Remarks
1	Raw Satellite Image	5 TB	For mn
2	1m Grid DEM (DSM)	2 TB	For management purposes
3	Satellite Ortho Image for island wide	3 TB	For management purposes
4	Image Tiling Data (for service purposes)	12 TB	
TOTAL		**22 TB**	

[Table Ⅴ-51] Total Storage Capacity for Data Management

No.	Category (purpose of use)	Calculated capacity
1	UAV image size	94.58 TB
2	Satellite image size	10 TB
	Subtotal	104.58 TB
A	Reserve rate (apply 30%)	104.58 TB x 130 % ≒ 135.95 TB
B	Physical size (considered the space for Raid configuration:40%)	135.95 TB x 140 % ≒ 190.33 TB
Applied storage size		≒ 200 TB

[Table Ⅴ-52] Total Storage Capacity for LAS

No.	Category (purpose of use)	Calculated capacity
1	Cadastral size	49.99 TB
2	UAV image size	95.75TB
3	Satellite image size	12 TB
	Subtotal	157.74 TB
A	Reserve rate (apply 30%)	157.74 TB x 130 % ≒ 205.06 TB
B	Reserve rate (apply 30%)	205.06 TB x 140 % ≒ 287.08 TB
Applied storage size		≒ 300 TB

[Table Ⅴ-53] Total Storage Capacity for LISS

No.	Category (purpose of use)	Calculated capacity
1	Reserve rate (apply 30%)	49.99 TB
	Subtotal	49.99 TB
A	Reserve rate (apply 30%)	49.99 TB x 130 % ≒ 64.98 TB
B	Reserve rate (apply 30%)	64.98 TB x 140 % ≒ 90.97 TB
Applied storage size		≒ 100 TB

2) Software Construction Plan

[Table Ⅴ-54] Software Construction Plan

Software	Main Roles and Proposed Specifications
Web Server	Plays the role of receiving http request from service requester and delivering the middleware request value
Application Server	Plays the role of an intermediary for the application of the LIS to operate between the service requester and the database Manage transactions, execute business logic to handle tasks, and interconnect applications between different systems
Database	Plays the role of storing and managing attribute and spatial data of the LIS
GIS Server	A server program that supplies various spatial data to the Internet GIS interface

Software	Main Roles and Proposed Specifications
Reporting S/W	Apply HTML5 to fully support web accessibility and web standards Provide a GUI development environment optimized for preparing complex reports with many tables and lines Send encrypted data between the server and client and ensure strong security such as a watermark in case of unauthorized tampering
Backup S/W	Physical environment, virtual environment, compact environment, large-scale IDC backup support Support various environments such as DAS, NAS, and SAN environment Automatically perform scheduled backup Provide diverse reporting functions with respect to backup
SSO S/W	Single authentication for C/S and web-based applications Support various authentication mechanisms such as security tokens, certificates, and smart cards

3) Network Construction Plan

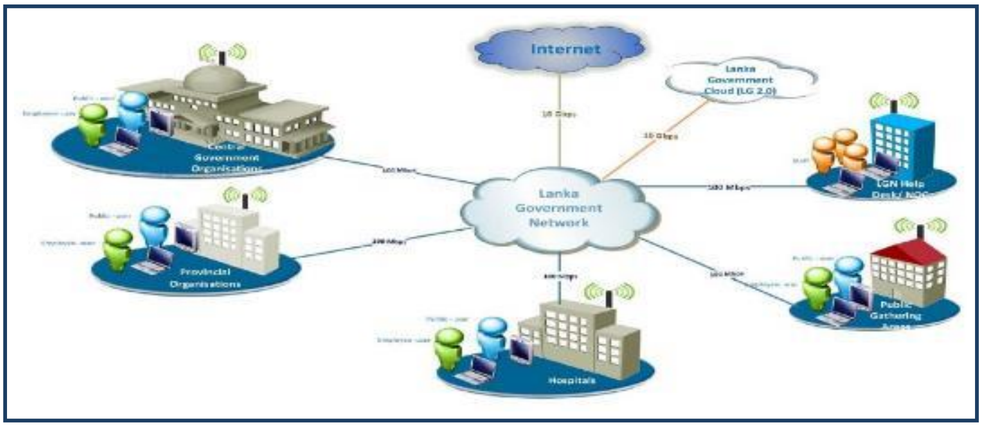
❍ The Sri Lanka LIS network will be designed taking into consideration stability, flexibility, s ecurity, scalability, etc.

❍ The main data center of the Sri Lanka LIS and the local survey offices will be connected u sing the LGN 2.0 network.

❍ LGN (Lanka Government Network) 2.0

– Overview

- Set up a network that can ensure reliability and safety for data exchange among government buildings by securing last mile connectivity based on optical cables
- Enable the use of Lanka Government Cloud (LGC) services and safe integration with LGN and the existing network of government agencies
- Promote network platforms to facilitate new applications such as a cloud-based email feature, G2G IP-based voice feature, and video conferencing feature

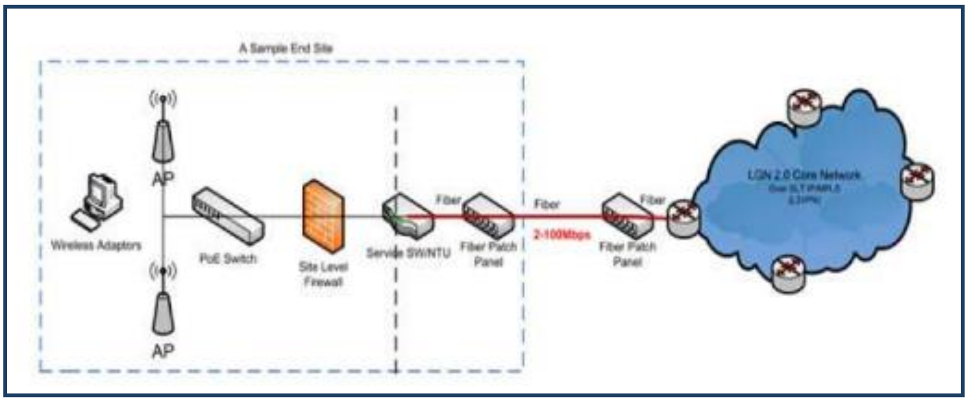


[Figure Ⅴ-33] LGN 2.0 Overview

– Main function

- The LGN 2.0 access network is an L3 VPN cloud.

- Remote access will be allowed via the shortest path through the core without routing.
- An Internet quota will be assigned to LGN users and requests for more may be made when necessary; however, data communication between government agencies and communication between regular agencies and LGC are not related to the quota system.
- All LGN wireless users must be authenticated through the captive portal in order to access the LGN network or internal network, but wired users only need to authenticate themselves when accessing the Internet.
- The hosting server is not directly exposed to the Internet via LGN.



[Figure Ⅴ-34] Block Diagram of Remote Area

– Scalability of LGN 2.0

- LGN from the Lanka Government Information Infrastructure (LGII) provides bandwidths as shown in the following table by designating a bandwidth group from A to E (50Mbps to 2Mbps) for each institution.

[Table Ⅴ-55] LGN 2.0 Bandwidth Group

Group	Recommended Bandwidth	Organization
A	50 Mbps	Ministry of Foreign Affairs and 6 other institutions
B	20 Mbps	ICTA(Information and Communication Technology Agency) and 8 other institutions
C	10 Mbps	Ministry of Telecommunication & Digital Infrastructure and 148 other institutions
D	5 Mbps	Unassigned
E	2 Mbps	577 other institutions

[Source] LGN 2.0 - Bandwidth Utilization Report as at June 19th 2018

- The assigned bandwidth group is not permanent. If the average bandwidth usage over the course of three months exceeds 85% and the maximum daily bandwidth reaches 70% in the last two weeks, the bandwidth can be immediately upgraded to the next group.
- However, according to a report on bandwidth usage released in June 2018, none of the 742 organizations that were provided the LGN service met the above criteria and saw an increase in their bandwidth.

- Moreover, the opposite (downgrade) is also possible. Thus, in the case of the new service of the SDSL, it is necessary to ensure the continuity of the bandwidth (50Mbps) assigned during the stabilization period through a separate procedure.

❍ The backbone switch should be designed as a sash type that is scalable, based on the antici pation that the traffic will rise in the future, and the main modules and power supply shoul d be made redundant to ensure stability. The switching capacity is determined as follows:.

❍ Bandwidth calculation reference table

[Table Ⅴ-56] Bandwidth calculation result

1st Category	Network bandwidth			LGN 2.0 B/W Group		Remarks (Excess rate)
	2nd Category	Calculation bandwidth	Estimated B/W	Current	Change	
Main Data Center	Public/Government portal services (Including UAV and satellite imagery)	Portal service : 6 Average data rate to be provided per portal service : 5 Kbps Consider e-Government scalability for the next five years : 1.5 times 6 nsider e-Government scalability for the Expected concurrent users : 1.12million(Civil servants) x Internet usage rate(32.05%) x Accessor(1%) x concurrent users(5%)=179 The estimated bandwidth : 45Kbps x 179(concurrent users)= 17.73 Mbps	40.53 Mbps	Group C 10M	Group A 50M	20%
	UAV Service & Satellite image Service	Average data rate to be provided per portal service : 100 Kbps(estimated) Consider e-Government scalability for the next five years : 1.5 times 84 Kbps e-Government scalability for t Expected concurrent users : 4000(surveying) x Internet usage rate(32.05%) x concurrent users(5%)= 64 The estimated bandwidth : 126Kbps x 64(concurrent users) = 9.60 Mbps				
	Survey data Up/Down Loading	25 locations District & 84 locations Divisional Survey Office : 109 locations Average bandwidth by regional offices according to LGN2.0-Bandwidth Utilization Report(2018) : 0.121Mbps The estimated bandwidth : 0.121Mbps x 109 locations = 13.2 Mbps				
DisSO	Government administrative service	SCAN topographic map transmission : about 2Mbps (estimated)	4.85 Mbps	Group E 2M	Group C 10M	51.5%
	Survey data up/Down Loading	Regional office maximum bandwidth according to LGN2.0-Bandwidth Utilization Report(2018) : 1.99 Mbps				
	UAV &	Portal service : 6				

1st Category	Network bandwidth			LGN 2.0 B/W Group		Remarks (Excess rate)
	2nd Category	Calculation bandwidth	Estimated B/W	Current	Change	
	Satellite image Service and portal	Average number of employees : 60 Expected concurrent users(5%): 3 명 The estimated bandwidth : (45Kbps+ 150Kbps) x 6 (concurrent accessor) = 0.585 Mbps				
DivSO	Apply the District Survey Office standard	No government administration.	2.85 Mbps	NONE	Group C 10M	72%

[Table Ⅴ-57] Results of Calculating the Backbone Switch Capacity

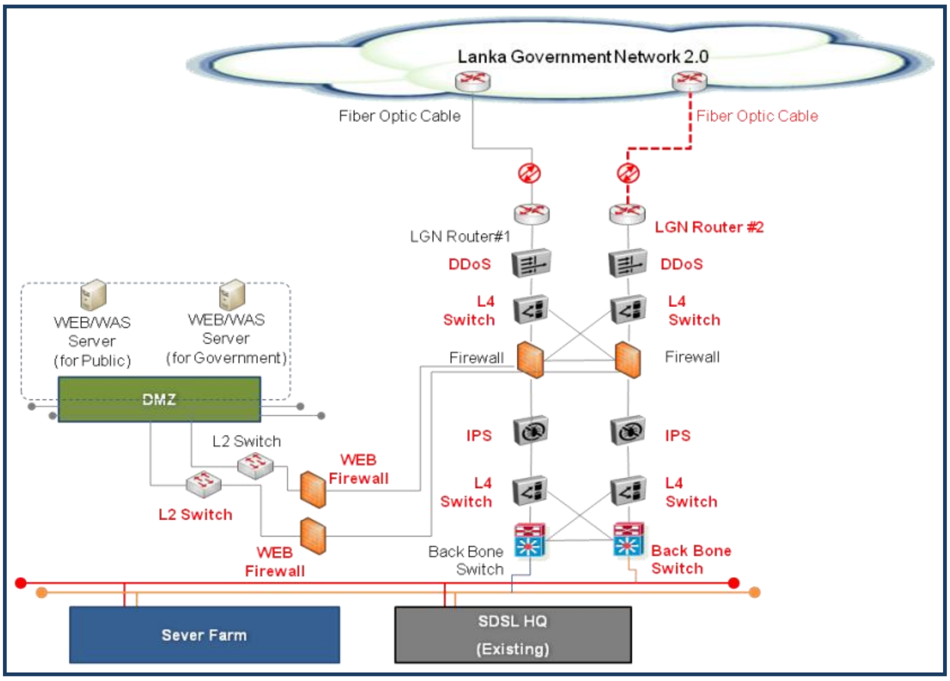
Software	Main Roles and Proposed Specifications
Number of switches installed	Three-story building, six 24-port per floor + 2 Server Farm Up Link Switches = 20 switches
Maximum traffic	20 units (quantity of switches) * 26Port (1 Gbps) * 2(bidirectional constant) = 520 Gbps x 2(bidirectional constant)= 1,040 Gbps
Reserve rate (30%)	1,040 Gbps x 1.3 = 1,352 Gbps
Backbone switch capacity	2 Tbps min.

❍ The master plan for the network composition of the Sri Lanka LIS is as follows.

– In order to provide a bypass route in case of equipment or circuit/line failure, the main equipment is designed to be redundant.

– 1Gbps connection for the main equipment interface

– Selected equipment that can support the interface of up to 10Gbps to prepare for interface scaling according to traffic increase



[Figure Ⅴ-35] Network Block Diagram

❍ As shown in the figure above, there are three types of zones centering on the backbone swi tch and they are comprised of the following:

– New Server Farm Zone

- Consists of internal Web/WAS/SSO servers, GIS server, database server, data connection server, backup server for data backup, and independent storages for LAS and LISS (reflected in infrastructure for VTL for large-capacity service DB in the future)
- Development Web/WAS server and development database server are simultaneously configured in the local and contractor's offices during system development and used in implementation simulation and testing
- Additional firewall is set up in front of server zone to protect the system from unauthorized users and viruses.
- Servers other than the existing servers are connected to the SAN switch, and the server data is stored in storage.

– DMZ Zone

- The DMZ Zone is comprised of Web/WAS servers for public services and a web firewall is set up in front of the server to protect it from external threats

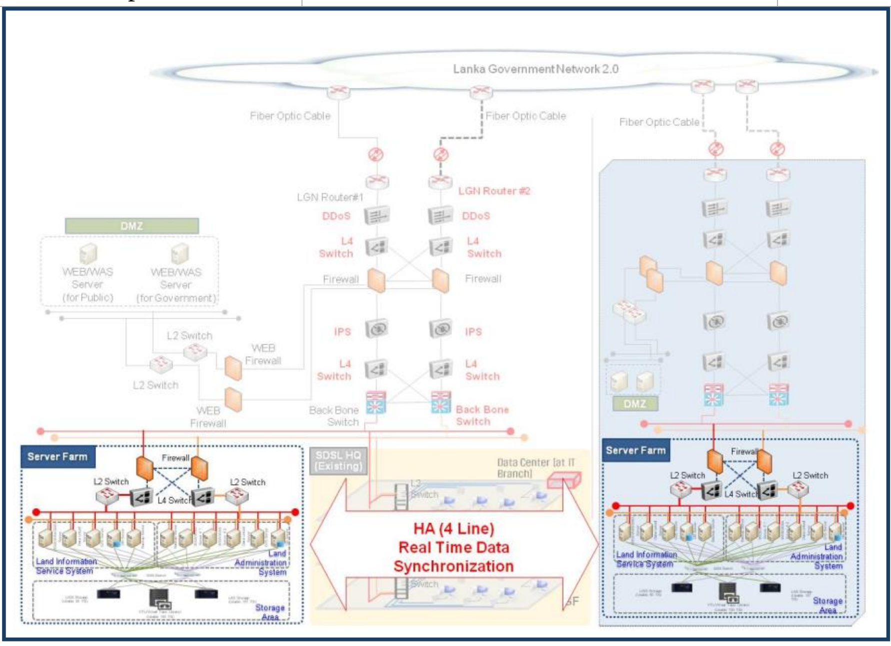
– Existing SDSL Network Zone

- Directly connect the backbone switch with the distributed switch on each floor using optical cables without installing any additional firewall
- Configure firewall load balancing (FWLB) using the L4 switch to distribute traffic coming in from the inside and outside and reduce the firewall load

❍ Set up a backup data center at SLT's Tier-III certified IDC to ensure continued system operat ion even in the event of an accident, emergency or natural disaster and to ensure quick recov ery.

[Table Ⅴ-58] Types and Characteristics of Disaster Recovery Centers

Category	Pros	Characteristics	Target recovery time	Selection
Mirror Site	Built as an identical system to the main center Real time data backup Operated at normal times	Fastest recovery and up-to-date data Ensure maximum stability and continuity of operations even in the event of a failure Increased cost due to redundant hardware and software	Within a few minutes	O
Hot Site	Built as an identical system to the main center Some data are remotely replicated Backup tape storage of important data Not operated at normal times	Lower cost than a mirror site and higher cost than a cold site Unable to guarantee continuity of operations in the event of a failure Difficult to maintain data consistency	Within a few hours	
Warm Site	Shortened infrastructure introduction time compared to the cold site as it is equipped with hardware, lines, etc. Backup tape storage of important data	Somewhat less expensive Prolonged recovery time (days or more Recovery rate of 90% or less (data are lost after backup)	1 day~1 week	
Cold Site	Space for system installation and only certain auxiliary facilities in place In the event of a disaster, hardware and software are introduced and installed for recovery Backup and store important data	Very low cost Recovery takes a long time Recovery rate of 90% or less (data are lost after backup)	None	

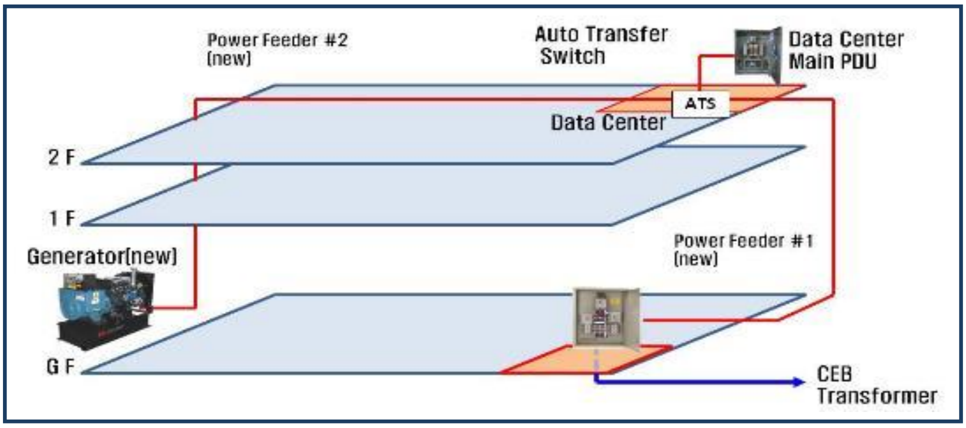


[Figure Ⅴ-36] NDC Data Backup Block Diagram

5.2.4.Supporting Facility Construction Plan

1) Power System

- The power facility construction plan is as follows:
  - The source power supplied through a transformer under the management of the Ceylon Electricity Board (CEB) is distributed from two electrical rooms inside the existing SDSL building.
  - In order to receive power supply from the power distribution panel on the Second(2nd) Floor where the main data center will be set up, it is necessary to carry out a comparative review of the supply design capacity and the current amount of power consumption; however, such review/verification is not possible because there are no schematic or connection diagrams of the power supply in the building.
  - Accordingly, the plan is to install a circuit breaker for the data center in the main distribution panel in Main electrical room located on the Ground Floor of the building, and compose a single three-phase line to provide redundant power supply.
  - Considering in case of power failure or abnormal power supply, install Diesel Generator newly. Composed of input power in data center through constant power and ATS (Auto Transfer Switch).



[Figure Ⅴ-37] Power Facility Diagram

- The plan is to install uninterruptible power supply (UPS) to maintain service and protect th e ICT infrastructure system in case of power interruption or power failure.

- UPS will be equipment with a facility management system (FMS) feature to ensure ease of maintenance.

- As for the battery, Li-ion battery was chosen to facilitate maintenance and repair in the futu re (e.g. use of additional batteries, scaling, replacement, and failure handling) and in consid eration of the computer room space and environment-friendly parts. The battery capacity sh ould be good enough to allow at least 30 minutes of operation in the event of a power fail ure.

- The pros and characteristics of the different batteries considered are as follows:

[Table Ⅴ-59] Battery Types and Characteristics

Item	Lithium ion	Lead acid	Nickel-hydogen
Ratio of power output to weight (Wh/kg)	190~210	20~40	50~80
Ratio of energy density to volume (Wh/L)	420	80~100	150~200
Operating temperature	-20~60℃	0~40℃	-20~50℃
Replacement period	1,200cycle	300cycle	1,000cycle
Environmentally hazardous substances	None	Lead and other hazardous substances	KOH
Configuration method	Parallel	Serial	Serial
Charging speed	Fast speed	Low speed	Fast speed
Stability	Very good	Average	Good
BMS	Included in the battery itself	Not incl.	Not incl.
Choice	O		

❍ The UPS capacity was determined based on the power requirements of the computer equipment in the main data center. Considering the total power consumption of 27,185W, efficiency of 80%, and margin of 30%, about 42.409kVA[32] is necessary, so the minimum UPS capacity was set to be 50kVA.

❍ The lithium ion battery capacity that would allow 30-hour operation during a power outage was found to be around 89AH.

– Li-ion battery capacity formula:

– UPS capacity (VA) x UPS power factor x Discharge time x 20% of capacity increase by hour rate

– Inverter efficiency x Termination voltage

[Table Ⅴ-60] Computer Equipment Power Consumption

Category	Equipment	Quantity	Power consumption(W)	
Servers	DMZ- Public Service WEB/WAS Server	1	750	750
	DMZ- Government Service WEB/WAS Server	1	750	750

32 UPS capacity = 27,185 W × 1.2 × 1.3 ≒ 42,409 V

Category	Equipment	Quantity	Power consumption(W)	
	LAS - WEB/WAS/SSO Server	1	750	750
	LISS - WEB/WAS/SSO Server	2	750	1,500
	DB Server	2	750	1,500
	Cluster Solution(HA)	1	600	600
	GIS Server	2	750	1,500
	Backup Server	2	750	1,500
	Data Connection Server	2	750	1,500
	WEB/WAS Development Server	1	750	750
	Development DB Server	1	750	750
	KVM S/W	1	27	27
Storage and Backup	SAN Switch	2	57	114
	Storage #1	1	1,000	1000
	Storage #2	1	1,000	1000
	VTL	1	950	950
Network	Backbone Switch	2	2,800	5,600
	L2 Switch	4	30	120
	L4 Switch	6	89	534
Security System	DDoS	2	550	1,100
	IPS	2	300	600
	Main Firewall	2	300	600
	Server Farm Firewall	2	100	200
	Web Firewall	2	400	800
	NMS/SMS/FMS	1	290	290
	Access Control	1	450	450
	ESM	1	550	550
	NDVR	1	200	200
	Access Control	1	450	450
	ESM	1	550	550
	NDVR	1	200	200

Category	Equipment	Quantity	Power consumption(W)
Total power consumption			27,185

- UPS power factor: 0.8, inverter efficiency: 90%, final voltage: 300, discharge time 30 minutes (0.5)
- The plan is to install 89AH battery and secure 1.5m[]^[2] of required area for 30 minutes of use based on 50KVA UPS' input voltage of 380V and output of 220V.

2) Generator Installation plan

❍ Plan to install an emergency generator to supply power to the UPS in the event of a strateg ic shutdown and power outage from the Cylon Electricity Board (CEB).

❍ A generator of 40KW or more is installed in the MDC (Main Data Center) considering the main equipment and auxiliary facilities.

❍ Emergency generators are generally divided into small-sized diesel engines and large-capacit y gas turbine generators. As a result of comparison, they plan to use universal and low-cost diesel engines.

❍ Capacity of Fuel Tank should be considered more than 1 day operation and should be provi ded with security facilities, in order to avoid the access by unauthorized person.

❍ The characteristics and pros of diesel engines and gas turbines are shown in the table belo w.

[Table Ⅴ-61] Generator Diesel vs Gas Turbine Engines

Category	Diesel engine	Gas turbine engine
Building use	Small size, Simple space	Medium to large size, Complex and demanding high reliability space
Application scale	15~20,000 kW	30~100,000 kW
Power generation efficiency	36~43%	21~40%
Overall efficiency	60~75%	70~80%
Fuel	Kerosene, Diesel, A heavy oil	Kerosene, Diesel, A heavy oil, Gas
Start-up time	Within 10 seconds	Within 40 seconds
Construction cost	Low price	Medium price
Pros	Cheaper price Fast start-up time Low fuel consumption rate	Excellent electrical properties High stability of power supply Simple basic equipment and low noise
Cons	High failure rate Environment problem Low power supply stability and high	High price more than diesel engine High fuel consumption rate Ambient temperature affects output

	vibration	characteristics
Selection	O	

3) HVAC(Heating, Ventilation, Air Conditioning) Equipment

- The plan is to install a thermo-hygrostat to keep the equipment room in the data center at a constant temperature and humidity level to prevent failures in the infrastructure system and to enhance the availability and reliability of the system.
- The thermo-hygrostat capacity was calculated by considering the amount of heat emitted by the equipment room area and computer equipment.
- The thermo-hygrostat capacity is estimated as 10RT, as shown below. The plan is to receive commercial power as the incoming power and be supplied the power from the generator in case of power failure.

[Table Ⅴ-62] Thermo-Hygrostat Capacity Calculations

Category	Field	Equation
Basic data	Data Center Area	26.65m^2 (40.47m^2 - 13.82m^2)
	Machine Heat Load	27.185KW x 860 = 23,379 kcal/hr
	Safety Factor	20%
Heat analysis	Data Center	26.65m^2 x 100 kcal/hr·m^2 = 2,665 kcal/hr
	Light Heat Load	21.32m^2 x 25.8 kcal/hr·m^2 = 550.06 kcal/hr
	Room Heat Load	2,665(Data Center) + 550.06(Light Heat Load) = 3,215 kcal/hr
	Machine Heat Load	23,379 kcal/hr
	Total Heat Load	3,215(Room Heat Load) + 23,379(Machine Heat Load) = 26,594 kcal/hr
	Safe Factor (20%)	26,594 kcal/hr x 1.2 = 31,913 kcal/hr
Capacity and quantity of thermo-hygrostat	Total RT	31,913 kcal/hr / 3,024[33] ≒ 10RT
	Quantity of Thermo-Hygrostat	10RT, 1 unit

4) Firefighting Equipment

❍ A firefighting system with an automatic fire extinguishing feature is installed to protect the computer equipment by rapid fire detection and suppression in the event of a fire.

33 1USRT = 3,024 kcal/hr (USRT: US Refrigeration ton

- A quick response is enabled by interworking the firefighting system with FMS, thermo-hygrostat, building firefighting equipment, etc.

- Use NOVEC-1230 fire extinguishing agent with low Ozone Depletion Potential (ODP), Global Warming Potential (GWP) and harmless to human body.

- Because the risk of fire is greater due to the cable at the bottom of the Raised Floor, a gas extinguishing equipment will be also be placed in the bottom of the Raised Floor.

- By interworking with the access control system, the detector will cut off the access control power before the gas is released in the event of a fire, and the doors will have to be opened by hand.

[Table Ⅴ-63] Pros and Cons of Fire Extinguishing Agents

Category	HFC-23	HFC-227ea	NOVEC 1230
Trade name	AnvFire, FE-13	FM-200, FE-227	3M NOVEC 1230
Molecular weight	70.01	170.03	361.04
Environmental regulations	None	Substances regulated by the Kyoto Protocol	NONE
Safety to humans	High	Low	Very high
Amount of agent per 1m^2	0.416kg	0.550kg	0.655kg
Pressure outlet	Applied only in fully closed areas	Applied only in fully closed areas	Applied only in fully closed areas
Setup cost	Inexpensive	Average	Average
Pros	Low price High concentrations, Low requirement Long range protection possible	Flexible filling management	Low human risk No restrictions on halogen High recharge rate, long term operation.
Cons	Always to charge fixed capacity High GWP than others Currently regulated in Europe	High Price Need to install nitrogen container separately Firefighting is not possible in an oil fire	Highest price Single developer exclusive supply
Selection			O

5) Physical Security Systems for the Data Center

- Establish a security system to safeguard the computer equipment from external threats and to prevent unauthorized access

- The security equipment is divided into an access control system for controlling access and CCTV for video surveillance.

- Access Control System

  – Application of access control devices incorporated with biometric, RFID or multiple authentication technology

– Differential application of access control methods according to the type of person trying to gain access

– Use of UPS for uninterrupted operation even in case of power failure

– Interconnected with the fire extinguishing system so that the doors have to be opened manually before the gas is released

❍ The plan for setting up the CCTV system is as follows:

– Select the top of the front and rear part of the rack so that there aren't any blind spots

– Allow CCTV footage to be saved and searched/retrieved for at least 3 months.

– Determine the video storage system considering the number of CCTV cameras installed and the footage retention period

[Table Ⅴ-64] Security Equipment Specifications and Installation Locations

Category	Specifications	Installation location	Quantity
Access control system	Fingerprint, number, RFID	Main Data Center	1 set
CCTV monitoring system	Camera - 2.1 Mega Pixel or higher - Total pixels 1945(H) x 1109(V) - Operating temperature and humidity level: - 10℃~55℃, no more than 90% RH	Inside the equipment room	2 units
		In front of the access door to the equipment room	1 unit
		Existing server room	1 unit
	NDVR (incl. monitor) - FULL HD: 1080P - 8 channels or higher - 10TB HDD or higher	Inside the center	1 unit

6) Interior

Raised Floor, cable tray, wall, ceiling, and lighting construction have been planned taking into consideration the characteristics of the main data center and the surrounding environment.

❍ Enclose the area with glass windows with bricks and other finishes so as to prevent unauth orized access.

❍ Raised Floor is installed in consideration of the ceiling height of the data center to ensure s ufficient space.

❍ To prevent condensation caused by cold air from the thermo-hygrostat on the bottom of the Raised Floor, an insulation material is installed on the floor.

– The cable tray installation plan is as follows:

– Install a communication tray for data cables to be installed between networks, security equipment, servers/storage devices and equipment

– Install a power supply tray to supply power from the UPS to the server and network rack

– Do not use the communication tray and the power tray for purposes other than the specific and keep them separate by at least 300mm.

5.2.5.Security Plan

1) Setup Overview

In order to protect the internal systems and data from various security threats, security policies and procedures are established and the following plan is set forth so as to ensure proper response to various security intrusions:

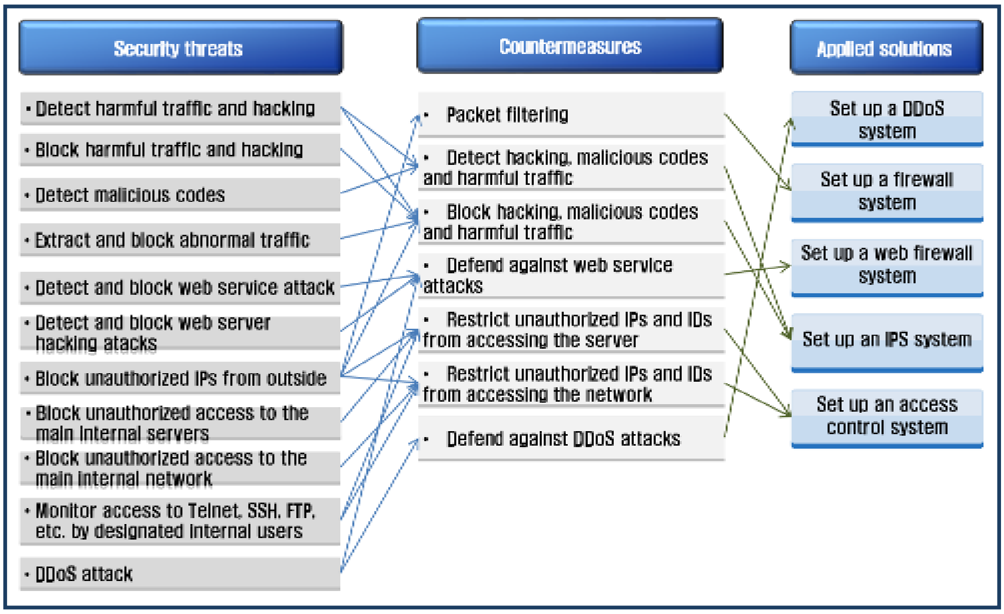
❍ Set up redundant DDoS equipment to counter distributed service attacks that cause service i nterruption by generating excessive traffic.

❍ The firewall system to block illegal access from the outside and inside and the intrusion pr evention system to block malicious codes from external sources as well as hacking are mad e redundant.

❍ An access control system is installed to block hackers and unauthorized users from accessing the network and servers, and web firewalls are set up in the DMZ Zone to counter web attac ks.

❍ An integrated security management system is established so as to prevent security threats in advance by collecting and analyzing security equipment logs.

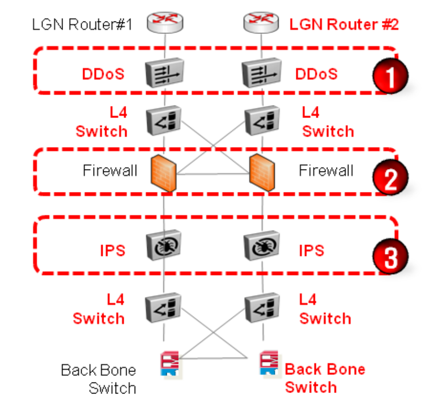
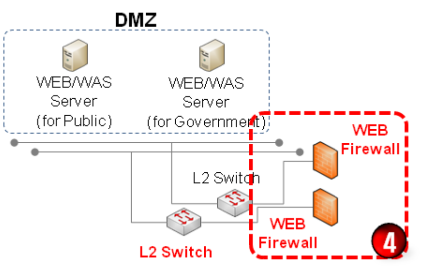
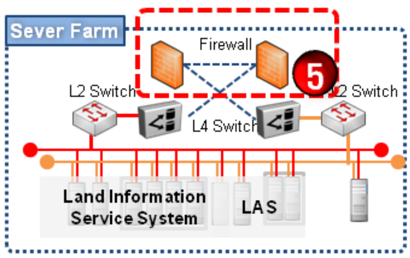
❍ The solutions applied to respond to various security threats are as follows:



[Figure Ⅴ-38] Solution Connection Diagram

2) Details of the Network Intrusion Prevention System

[Table Ⅴ-65] Details of the Network Intrusion Prevention System

Composition	No.	System	Description
	1	DDoS[34]	A system that blocks DDoS attacks which instantly paralyze servers by generating a large amount of traffic that cannot be handled by a server or network band
	2	Firewall	A system that blocks illegal access from the outside to the inside or from the inside to the outside for the purpose of ensuring information security when an internal network connects to an external network such as the Internet
	3	IPS[35]	A system that implements defense measures such as detection, blocking, and isolation against abnormal traffic based on various hacking methods
	4	WEB Firewall	A system that provides security against web application vulnerabilities and analyzes and blocks original hacking attacks by filtering web protocols (HTTP: 80) coming in from the outside
	5	Internal Firewall	A system that blocks access by internal infected users and unauthorized persons from the inside to ensure server security

34 DDoS: Distributed Do

35 IPS: Intrusion Prevent Syste

5.3.Local Survey Office Operating Infrastructure Establishment Plan

5.3.1.Local Survey Office Spatial Planning

[Table Ⅴ-66] 24 Major MCs and Local Survey Offices

Province	District Survey Office	Local Authority	Divisional Survey Office
Western	Colombo	Colombo MC	Colombo, Kesbewa, Homagama
		Dehiwala-Mount MC	
		Kaduwela MC	
		Moratuwa MC	
		Sri Jayawardanapura Kotte MC	
	Gampaha	Gampaha MC	Attanagalla-Bimsaviya, Gampaha, Ja-ela/ Wattala-Bimsaviya
		Negombo MC	
	Kalutara		Kalutara - Bimsaviya, Mathugama, Horana, Pelawatta
North Western	Kurunegala	Kurunegala MC	Kurunegala-Bimsaviya, Maho, Wariyapola, Galgamuwa, Nikaweratiya
	Puttalam		Anamaduwa, Madampe, Puttalam
Northern	Jaffna	Jaffna MC	Jaffna
	Kilinochchi		Kilinochchi, Kilinochchi 2
	Mullaattivu		Mullattivu, Mankulam
	Vavuniya		Vavuniya, Vavuniya 2
	Mannar		Mannar
Central	Kandy	Kandy MC	Digana, Harispaththuwa-Bimsaviya, Kandy, Udunuwara- Bimsaviya (Doluwa), Yatinuwara, Minipe
	Matale	Dambulla MC	Dambulla, Matale, Laggala

Province	District Survey Office	Local Authority	Divisional Survey Office
		Matale MC	
	Nuwaraeliya	Nuwaraeliya MC	Kothmale, Nuwara-Eliya
North Central	Anuradapura	Anuradapura MC	Anuradhapura, Kekirawa, Thambuththegama-Bimsaviya, Medawachchiya, Padaviya, Thirappane
	Polonnaruwa	Polonnaruwa MC	Girithale, Hinguraggoda, Kaduruwela
Eastern	Baticaloa	Baticaloa MC	Batticaloa, Vantharumoolai, Vellavelli
	Trincomalee		Kantale, Trincomalee
	Ampara	Akkaraipattu MC	Akkaraipattu, Ampara, Mahaoya, Sammanthurai
		Kalmunai MC	
Southern	Galle	Galle MC	Elpitiya, Galle, Udugama, Baddegama
	Matara	Matara MC	Akuressa, Matara, Kamburupitiya, Kotapola
	Hambantota	Hambantota MC	Angunakolapelessa, Hambanthota, Thissa-Bimsaviya, Weeraketiya
Sabaragamuwa	Rathapura	Rathapura MC	Embilipitiya, Kalawana, Pelmadulla, Rathnapura, Elapatha - > Rathnapura 2, Balangoda
	Kegalle		Kegalle, Ruwanwella, Galigamuwa
UVA	Badulla	Badulla MC	Badulla, Bandarawela, Rideemaliyadda (Mahiyangana), Welimada
		Bandarawela MC	
	Monaragala		Bibila, Monaragala, Galabedda, Thanamalvila

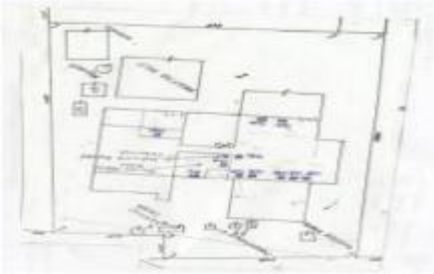
[Table Ⅴ-67] District Survey Office Spatial Planning

District Survey Office

Category	Details	Location Map & Planar Drawing
1. Polonnaruwa District Survey Office	Latitude: 7˚54′ 59.7" N Longitude: 81˚00' 00.1" E	
Location	Ground Floor	
Total area	3.45 x 4.65 m	
Height	3.3 m	
Main Network	LGN	
PCs (Admin/BS/LIS/etc.)	10 (3/0/2/5)	
Incoming Voltage	230 V	
MCB Size	40 A	

Category	Details	Location Map & Planar Drawing
2. Tricomalee District Survey Office	Latitude: 8˚34′ 12.4" N Longitude: 81˚13' 47.5" E	
Location	Ground Floor	
Total area	11 x 25 m	
Height	3.45 m	
Main Network	LGN	
PCs (Admin/BS/LIS/etc.)	11 (4/0/1/7)	
Incoming Voltage	230 V	
MCB Size	40 A	

Category	Details	Location Map & Planar Drawing
3. Batticaloa District Survey Office	Latitude: 7˚43′ 08.4" N Longitude: 81˚41' 56.8" E	
Location	Ground Floor	
Total area	11 x 25 m	
Height	3.45 m	

Main Network	LGN	
PCs (Admin/BS/LIS/etc.)	10 (6/0/1/3)	
Incoming Voltage	230 V	
MCB Size	40 A	

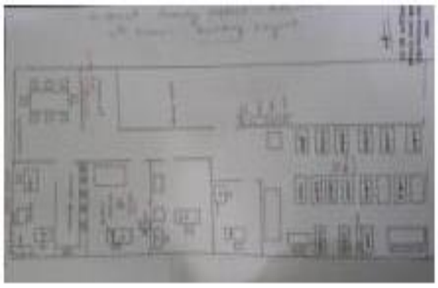
Category	Details	Location Map & Planar Drawing
4. Ampara District Survey Office	Latitude: 7˚17′ 41.1" N Longitude: 81˚40' 28.5" E	
Location	Ground Floor	
Total area	6.1 x 7.4 m	
Height	4 m	
Main Network	LGN	
PCs (Admin/BS/LIS/etc.)	10 (4/0/2/4)	
Incoming Voltage	230 V	
MCB Size	10_40 A	

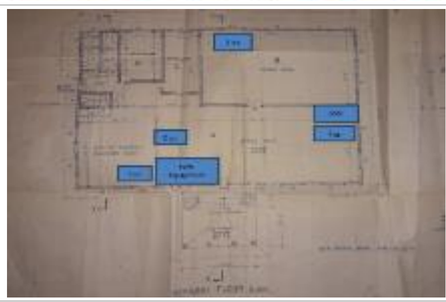
Category	Details	Location Map & Planar Drawing
5. Matale District Survey Office	Latitude: 7˚28′ 02.3" N Longitude: 80˚37' 07.9" E	
Location	2nd Floor	
Total area	2.5 x 3.2 m	
Height	2.4 m	
Main Network	LGN	
PCs (Admin/BS/LIS/etc.)	9 (2/1/1/4)	
Incoming Voltage	230 V	
MCB Size	40 A	

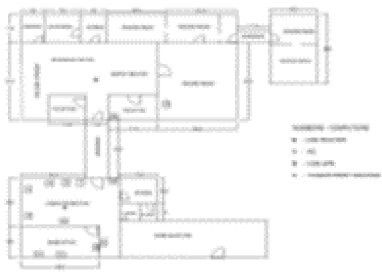
Category	Details	Location Map & Planar Drawing
6. Nuwara-Eliya District Survey Office	Latitude: 6˚58′ 46.8" N Longitude: 80˚45' 25.6" E	
Location	Ground Floor	
Total area	4.4 x 2.4 m	
Height	2.5 m	
Main Network	LGN	
PCs (Admin/BS/LIS/etc.)	10 (2/1/1/6)	
Incoming Voltage	230 V	
MCB Size	40 A	

Category	Details	Location Map & Planar Drawing
7. Puttalam District Survey Office	Latitude: 8˚01′ 36.4" N Longitude: 79˚49' 58.2" E	
Location	Ground Floor	
Total area	3.0 x 3.4 m	
Height	3.0 m	
Main Network	LGN	
PCs (Admin/BS/LIS/etc.)	11 (9/0/2/0)	
Incoming Voltage	230 V	
MCB Size	16 A	

Category	**Details**	**Location Map & Planar Drawing**
8. Kalutara District Survey Office	Latitude: 6˚34′ 55.8" N Longitude: 79˚57' 42.8" E	
Location	4th Floor	
Total area	23 x 8 m	

Height	3.5 m	
Main Network	LGN	
PCs (Admin/BS/LIS/etc.)	13 (2/1/1/9)	
Incoming Voltage	415 V	
MCB Size	32 A	

Category	Details	Location Map & Planar Drawing
9. Kegalle District Survey Office	Latitude: 7˚15′ 17.9" N Longitude: 80˚20' 59.7" E	
Location	Ground Floor	
Total area	6.2 x 7.6 m	
Height	4.0 m	
Main Network	LGN	
PCs (Admin/BS/LIS/etc.)	8 (7/0/1/0)	
Incoming Voltage	230 V	
MCB Size	30 A	

Category	Details	Location Map & Planar Drawing
10. Badulla District Survey Office	Latitude: 6˚59′ 27.1" N Longitude: 81˚03' 28.1" E	
Location	Ground Floor	
Total area	3.9 x 7.7 m	
Height	3.4 m	
Main Network	LGN	
PCs (Admin/BS/LIS/etc.)	11 (6/1/2/2)	
Incoming Voltage	230 V	
MCB Size	40 A	

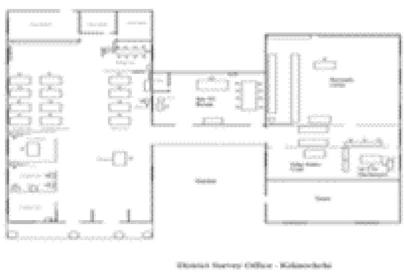
Category	Details	Location Map & Planar Drawing
11. Monaragala District Survey Office	Latitude: 6˚51′ 29.2" N Longitude: 81˚20' 27.9" E	
Location	Ground Floor	
Total area	6.25 x 7.77 m	
Height	3.35 m	
Main Network	LGN	
PCs (Admin/BS/LIS/etc.)	10 (7/1/1/1)	
Incoming Voltage	415 V	
MCB Size	30 A	

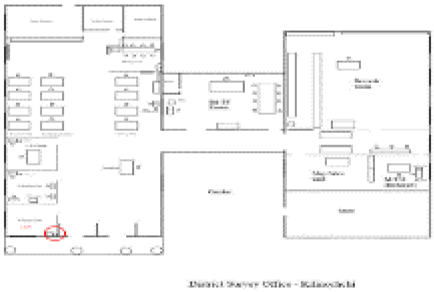
Category	Details	Location Map & Planar Drawing
12. Matara District Survey Office	Latitude: 5˚57′ 24.3" N Longitude: 80˚32' 40.9" E	
Location	Ground Floor	
Total area	18 x 6 m	
Height	10 m	
Main Network	LGN	
PCs (Admin/BS/LIS/etc.)	11 (4/1/2/4)	
Incoming Voltage	415 V	
MCB Size	60 A	

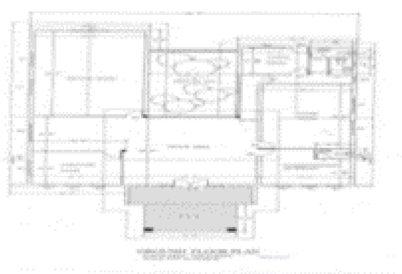
Category	Details	Location Map & Planar Drawing
13. Hambanthota District Survey Office	Latitude: 6˚08′ 00.3" N Longitude: 81˚07' 41.8" E	
Location	Ground Floor	
Total area	7.5 x 6.0 m	

Height	10 m	
Main Network	LGN	
PCs (Admin/BS/LIS/etc.)	8 (2/1/1/4)	
Incoming Voltage	415 V	
MCB Size	30 A	

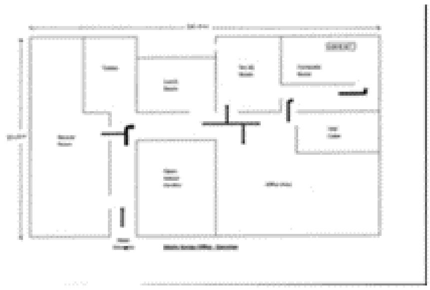
Category	Details	Location Map & Planar Drawing
14. Jaffna District Survey Office	Latitude: 9˚39′ 29.9" N Longitude: 80˚01' 43.7" E	
Location	Ground Floor	
Total area	3.5 x 5 m	
Height	3 m	
Main Network	LGN	
PCs (Admin/BS/LIS/etc.)	7 (2/1/1/3)	
Incoming Voltage	230 V	
MCB Size	63 A	

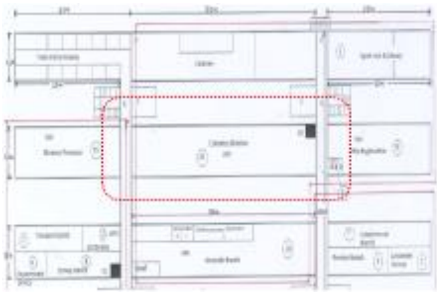
Category	Details	Location Map & Planar Drawing
15. Killnochchi District Survey Office	Latitude: 9˚23′ 32.9" N Longitude: 80˚24' 20.2" E	
Location	Ground Floor	
Total area	4.2 x 2.4 m	
Height	2.8 m	
Main Network	SLT	
PCs (Admin/BS/LIS/etc.)	7 (1/1/1/4)	
Incoming Voltage	415 V	
MCB Size	32 A	

Category	Details	Location Map & Planar Drawing
16. Mullaattivu District Survey Office	Latitude: 9˚16′ 21.1" N Longitude: 80˚49' 01.5" E	
Location	Ground Floor	
Total area	6 x 4 m	
Height	4 m	
Main Network	LGN	
PCs (Admin/BS/LIS/etc.)	6 (3/1/1/1)	
Incoming Voltage	415 V	
MCB Size	32 A	

Category	Details	Location Map & Planar Drawing
17. Mannar District Survey Office	Latitude: 8˚53′ 26.3" N Longitude: 79˚59' 51.3" E	
Location	Ground Floor	
Total area	18 x 15 m	
Height	3.4 m	
Main Network	SLT	
PCs (Admin/BS/LIS/etc.)	-	
Incoming Voltage	415 V	
MCB Size	32 A	

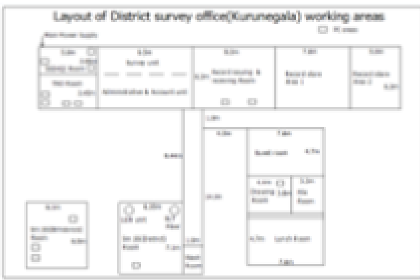
Category	Details	Location Map & Planar Drawing
18. Vavunlya District Survey Office	Latitude: 8˚45′ 26.5" N Longitude: 80˚29' 43.7" E	
Location	Ground Floor	
Total area	4.37 x 3.67 m	

Height	2.86 m	
Main Network	SLT	
PCs (Admin/BS/LIS/etc.)	8 (3/0/2/3)	
Incoming Voltage	415 V	
MCB Size	40 A	

Category	Details	Location Map & Planar Drawing
19. Colombo District Survey Office	Latitude: 6˚53′ 33.1" N Longitude: 79˚52' 26.2" E	
Location	1st Floor inside the Head Office	
Total area	25 x 8 m	
Height	3.3 m	
Main Network	LGN	
PCs (Admin/BS/LIS/etc.)	10 (3/1/1/5)	
Incoming Voltage	230 V	
MCB Size	100 A	

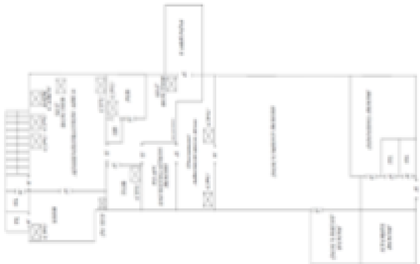
Category	Details	Location Map & Planar Drawing
20. Galle District Survey Office	Latitude: 6˚02′ 14.6" N Longitude: 80˚13' 01.3" E	
Location	Ground Floor	
Total area	5 x 7 m	
Height	2.8 m	
Main Network	LGN	
PCs (Admin/BS/LIS/etc.)	-	
Incoming Voltage	220 V	
MCB Size	32 A	

Category	Details	Location Map & Planar Drawing
21. Kandy District Survey Office	Latitude: 7˚17′ 28.6" N Longitude: 80˚38' 38.5" E	
Location	Ground Floor	
Total area	20 x 15 m	
Height	3.1 m	
Main Network	LGN	
PCs (Admin/BS/LIS/etc.)	-	
Incoming Voltage	415 V	
MCB Size	60 A	

Category	Details	Location Map & Planar Drawing
22. Kurunegala District Survey Office	Latitude: 7˚28′ 42.2" N Longitude: 80˚21' 54.9" E	
Location	Ground Floor	
Total area	6.3 x 7.3 m	
Height	3.4 m	
Main Network	SLT	
PCs (Admin/BS/LIPCs (Admin/BS/LIS/etc.)S/etc .)	-	
Incoming Voltage	220 V	
MCB Size	32 A	

Category	Details	Location Map & Planar Drawing
23. Anuradhapura District Survey Office	Latitude: 8˚19′ 44.8" N Longitude: 80˚24' 36.2" E	
Location	Ground Floor	
Total area	4.5 x 4.5 m	

Height	2.8 m	
Main Network	LGN	
PCs (Admin/BS/LIS/etc.)	-	
Incoming Voltage	415 V	
MCB Size	63 A	

Category	Details	Location Map & Planar Drawing
24. Rathnapura District Survey Office	Latitude: 6˚40′ 45.3" N Longitude: 80˚24' 10.2" E	
Location	Ground Floor	
Total area	7.5 x 7.6 m	
Height	3 m	
Main Network	LGN	
PCs (Admin/BS/LIS/etc.)	-	
Incoming Voltage	220 V	
MCB Size	32 A	

Category	Details	Location Map & Planar Drawing
25. Gampaha District Survey Office	Latitude: 7˚05′ 08.7" N Longitude: 80˚00' 43.6" E	
Location	Ground Floor	
Total area	7.8 x 6.3 m	
Height	3.45 m	
Main Network	LGN	
PCs (Admin/BS/LIS/etc.)	-	
Incoming Voltage	415 V	
MCB Size	32 A	

5.3.2.Details of the Equipment Introduced into Local Survey Offices

- The equipment for improving the network environment of the district survey offices (25 locations) and divisional survey offices (84 locations) of the Sri Lanka LIS are as follows:

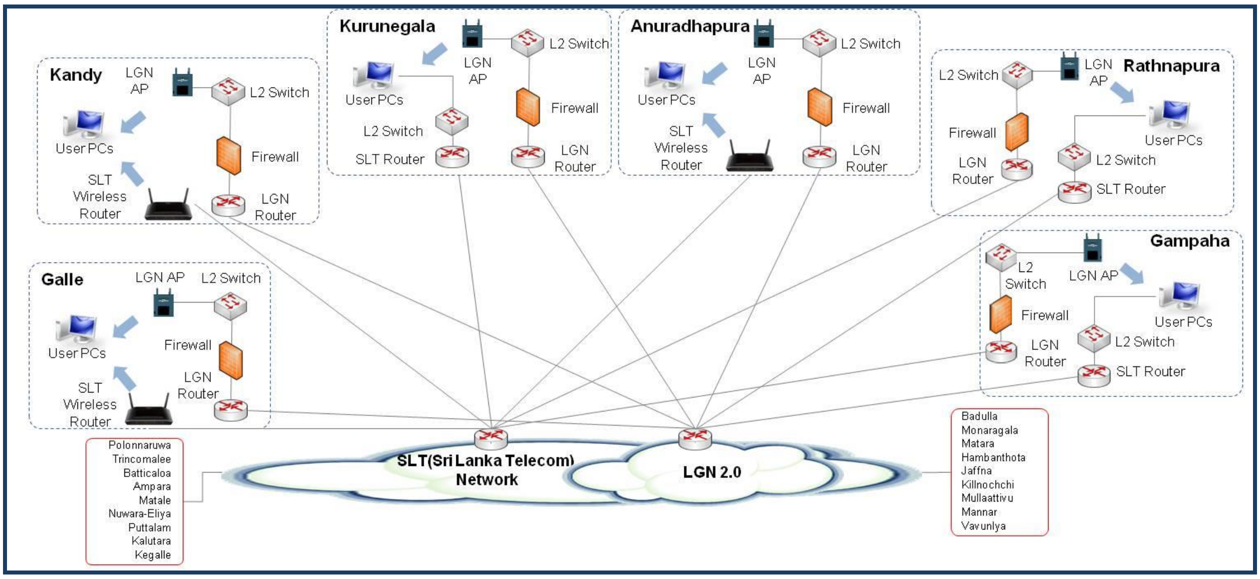
[Table Ⅴ-68] Specifications and Quantity of Equipment Introduced to District Survey Offices

Category	Equipment	Quantity	Number of locations	Total quantity	Remarks
District Survey Office	L2 Switch	1	25	25	
	Patch Panel	2	25	50	
	Workstation (incl. monitor and keyboard)	2 Set	25	50	
	NAS Storage (Physical 10 TB)	1	25	25	
	Scanner	1	25	25	
	Rack Mountable UPS	1 EA	25	25	
	UTP Cable (25m per outlet)	375 m	25	38 Roll	1 Roll: 250 m
	Outlet Module	15	25	375	UK Type
	Half-size Rack	1	25	25	H:1000
Divisional Survey Office	F/O Patch Panel	1	84	84	
	LGN Router	1	84	168	
	Fire wall	1	84	84	
	L2 Switch	1	84	84	
	Patch Panel	2	84	164	
	Rack Mountable UPS	1	84	84	
	UTP Cable (5m per outlet)	5	84	2 Roll	
	Outlet Module	1	84	84	UK Type
	Half-size Rack	1	84	84	H:1000

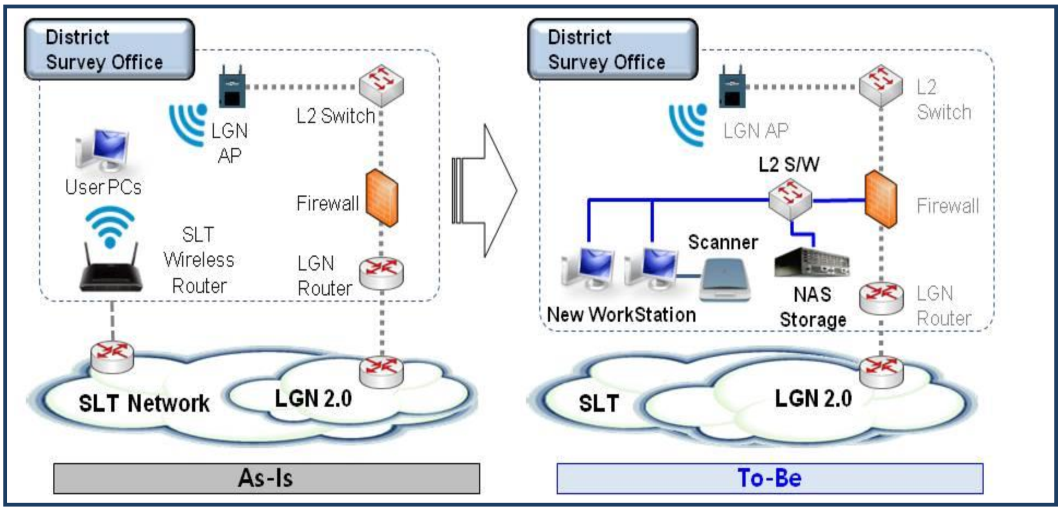
5.3.3.Network Construction Plan

1) District Survey Offices

- ❍ At present, the LGN 2.0 network is in operation, but data communication is via wireless AP, instead of an internal private network (i.e. Intranet) within the office.
- ❍ There are interruptions in the long-distance communication due to interference caused by the old building and limited AP assignment.
- ❍ There are problems of long loading time and low work efficiency when accessing the server in operation because the PCs used for the LIS and Bim Saviya Program are old, outdated with poor specifications.
- ❍ The scope of improvement of the working environment of district surveying offices includes construction of an intranet using a wired network inside the office and replacing low-spec and outdated PC-level operating equipment with workstation-level equipment.



[Figure Ⅴ-39] Existing Network Block Diagram



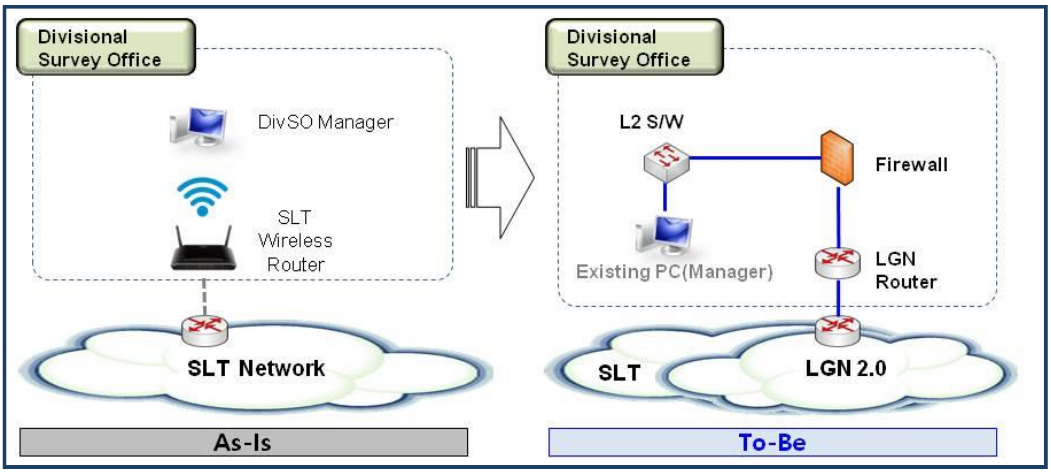
[Figure Ⅴ-40] Measures for Improving the Network of District Survey Offices

2) Divisional Survey Offices

- ❍ Despite being the places where most of the surveying work and the upload of survey data are occurred, the LGN 2.0 network is not currently available. Thus, data communication is via the SLT leased network.

- ❍ Local, ADSL, or equivalent services are received and a monthly network fee is charged.

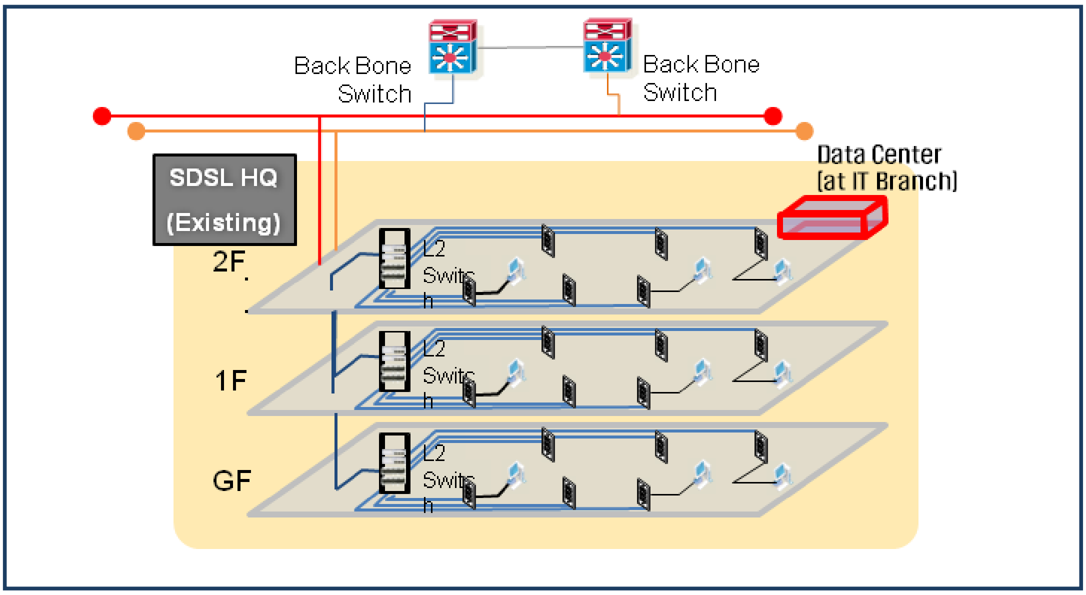
- ❍ The scope of improvement of the working environment of divisional survey offices includes application of LGN 2.0 in the office so as to improve the bandwidth among the survey offices and the efficiency of connection with other entities.



[Figure Ⅴ-41] Measures for Improving the Network of Divisional Survey Offices

5.3.4.Construction Plan in Connection with the Existing System and Infrastructure

- ❍ Intranet within SDSL HQ
  - – The existing intranet is connected to the bottom of the backbone switch of the newly installed redundant network.
  - – The switching procedure under the circumstances of redundancy is sequential patching based on the time when the work is completed after the new system is set up.



[Figure Ⅴ-42] Existing Building Intranet Connection Diagram

❍ Existing Land Information System (LIS)

– The SDSL is currently operating a land information system it has set up on its own, but it will be expanded into a land administration system (LAS) and a land information service system (LISS) through this project. A step-by-step system construction plan has been established so that current services can be provided without any interruption during the project period.

[Table Ⅴ-69] Step-by-Step ICT Construction Plan

Step	Category	SDSL HQ		NDC Backup Data Center	Remarks
		Existing LIS	New LAS & LISS		
1	Major Equipment installation	In operation	N/A	Established	
	Operation Test	In operation	N/A	Test	
2	Construction for Interior	In operation	N/A	Test	
	Alternative Operation with new System	Suspended	N/A	In operation	
	Demolition of Existing System	Demolished	N/A	In operation	
3	Major Equipment installation	N/A	Established	In operation	
	Operation Test at SDSL HQ	N/A	Test	In operation	
	Integration Test	N/A	Redundant	Redundant	

6.Capacity Building Plan

6.1.Capacity Building Overview

❍ A short-term training plan for the execution of this project and a mid- and long-term capaci ty building plan for stable operation of the land information infrastructure are set forth, bas ed on the analysis of the current problems and requirements with respect to the education a nd training in Sri Lanka, and systematic education and training will be carried accordingly.

❍ Since this project involves a wide range of target institutions and target areas, effective cust omized training is necessary for the various targets, and actual capacity building is needed i n order to digitize the old drawings, perform field repletion surveys and create a spatial dat abase using the local personnel.

❍ Also, the ISM was established 50 years ago, and the curriculum of the current education an d training provided at an outdated educational facility is limited or leans toward surveying, mapping, etc. Therefore, there is a need to add and reinforce the areas of training that are l acking such as ICT-based digitization training and redesign the capacity building program s o as to produce synergy in the long run. Need to redesign Capacity Building to be effective

- To this end, this project is divided into field-oriented customized intensive local training, training of key stakeholders (management and working level) in Korea, and OJT for cultivating core working-level human resources. The old and outdated training environment and facilities will be improved in order to boost the effectiveness of education and training.

6.2.Invitation Training in Korea

- The training program in Korea is organized as follows to promote the understanding of the project among the project implementers from the SDSL (HQ, district survey offices and divisional survey offices) and the 24 municipal councils.

- A total of 57 participants will be invited for training, which will be divided into two sessions that will be administered for two weeks each. The training will be comprised of lectures, equipment operation practice, visits to related institutions, and field trips.

[Table Ⅴ-70] Training Program in Korea

Target (persons)	Program	
1st group of trainees: 30 people (2 people from SDSL, 12 people from the District Survey Office, 12 people from the MCs and 2 people from relevant central agencies, 2 people from Ministries)	Week 1	• Introduce Korea's land policy cases and land development experience • Visit relevant institutions to present the current status in relation to the establishment of an advanced land information system
	Week 2	• Demonstration of surveying systems such as UAV, TOSS, RTK, etc. • Visit the sites of digitization of land information and network construction
2nd group of trainees: 30 people (2 people from SDSL, 13 people from the District Survey Office, 12 people from the MCs and 2 people from relevant central agencies, 1 people from Ministry)	Week 1	• Introduce Korea's land policy cases and land development experience • Visit relevant institutions to present the current status in relation to the establishment of an advanced land information system
	Week 2	• Demonstration of surveying systems such as UAV, TOSS, RTK, etc. • Visit the sites of digitization of land information and network construction

* Trainee will be selected by the SDSL and participating organizations.

6.3.Training for Fostering Local Instructor

- While capacity building is basically run by Korean experts, fostering professional instructors is essential for capacity building and continuing education and training throughout Sri Lanka.

- For key practitioners in each field of the main office of the Korea Research Institute, the backbone of the project, Korean experts are dispatched to the local education center for two months to provide intensive training at the same time in the same time.

[Table Ⅴ-71] Subjects of instructor-trained persons

Trainee Affiliation	Field	Subjects(People)	Training Period	Korean Trainers(People)
SDSL Headquarters	Data center and IT network	4	2 months	2
	System (Land management system)	4	2 months	2
	Geometix	4	2 months	2
	Data acquisition and survey	4	2 months	2
Total		16		8

※ Trainees are selected by SDSL

❍ The specialized instructors who receive training for instructors can establish a sustainable education system for the operators of the institutions under project during the project period and for the entire country after the project is completed.

[Table Ⅴ-72] Training program for fostering instructor

Category	Common contents /hour (h)	Training Contents per sector	Total hours (h)
IT infrastructure	NSDI(Concept and cases) /6h(6h * 1day) LIS((Concept and cases) /6h(6h * 1day) Data sharing and conversion((Concept and cases) /12h(6h * 2days) GIS(Concept and cases) /6h(6h * 1day)	Basic theories and operation theories regarding IT network, security, and equipment	90 (6 h * 15 days)
		Practicing setup and operation of IT network, security, equipment, etc.	144 (6 h * 24 days)
Land management system operation and management		Lectures on LIS regulations, policies, operations, etc.	90 (6 h * 15 days)
		Cadastral data processing practice	144 (6 h * 24 days)
Geoinformatics (GIS)		GIS-related theories such as spatial information modeling	90 (6 h * 15 days)
		Practicing data display, query setup, etc.	144 (6 h * 24 days)
Land registration data acquisition and direct repletion surveying (CORS, GNSS, UAV, etc.)		Flight theories related to CORS, UAV, etc.	30 (6 h * 5 days)
		Practicing drone and GNSS surveying	48 (6 h * 8 days)
		T/S operation theories	30 (6 h * 5 days)
		Surveying software operation practice	42 (6 h * days)

※ The instructor-led training program provides a one-week common training program as above, and from the second week, the theory and practice are tailored to the characteristics of each field.

6.4.Expansion Local Training for Sri Lankan Operator

- The survey agency and relevant agencies selected one person in charge of each of the following four areas in advance for each project site and trained by a local expert instructor through the instructor-led program, and Korean experts who conducted the instructor-led training program will participate as supervisors.

- Local education is provided by ISM for a total of 2 months in 4 sectors, i.e. IT (open source-based), land management system operation and management, GIS-based Geomatix, land registration data acquisition and direct complementary measurement.

- Since large numbers of people are trained, four classrooms are run sequentially as follows:

- \- 138 in primary IT → 138 in secondary systems → 138 in tertiary geomatix → 138 in secondary data acquisition and survey DB sector

[Table Ⅴ-73] Subjects of Expansion Local Training for Sri Lanka Operator

Target entity	Number of Training Subjects(People)	Number of Trainees by Field(People)
SDSL HQ	4	1
25 district offices	100	25
85 divisional offices	336	85
24 municipal councils	96	24
Department of Registrar General's	4	1
Department of Land Commissioner General's	4	1
Land Settlement Department	4	1
Land Use Policy Department	4	1
Total	552	138

[Table Ⅴ-74] Subjects of Expansion Local Training for Sri Lanka Operator

Field	Local Instructor Input	Korean Expert(Supervisor) Input
IT infrastructure	40 MD (4 persons * 10 days)	10 MD (1 persons * 10 days)
Land management system operation and management	40 MD (4 persons * 10 days)	10 MD (1 persons * 10 days)

Field	Local Instructor Input	Korean Expert(Supervisor) Input
Geoinformatics (GIS)	40 MD (4 persons * 10 days)	10 MD (1 persons * 10 days)
Land data acquisition and direct repletion surveying	40 MD (4 persons * 10 days)	10 MD (1 persons * 10 days)

❍ The following programs are provided for two weeks for each field.

[Table Ⅴ-75] Training Program of Expansion Local Training for Sri Lankan Operator

Field	Training contents per sector	Duration (days) per sector
IT infrastructure	Basic theories and operation theories regarding IT network, security, and equipment	30 (6 h * 5 days)
	Practice of operation regarding IT network, security, and equipment	30 (6 h * 5 days)
Land management system operation and management	Lectures on LIS regulations, policies, operations, etc	30 (6 h * 5 days)
	Cadastral data processing practice	30 (6 h * 5 days)
Geoinformatics (GIS)	GIS-related theories such as spatial information modeling	30 (6 h * 5 days)
	Practicing data display, query setup, etc.	30 (6 h * 5 days)
Land data acquisition and direct repletion surveying	Flight theories related to CORS, UAV, etc.	12 (6 h * 2 days)
	Practicing drone and GNSS surveying	18 (6 h * 3 days)
	T/S operation theories	12 (6 h * 2 days)
	Surveying software operation practice	18 (6 h * 3 days)

6.5. On the Job Training (Field Practice)

❍ Experts from SDSL will be dispatched to Korea for the system development period and have them participate during local construction so that they can become the core personnel for future system operation.

❍ OJT will last for thirty six (36) months in Sri Lanka. The six (6) trainees will participate in system development along with Korean experts in system development, installation, equipment testing, etc. so as to ensure smooth system operation, maintenance and repair.

[Table Ⅴ-76] OJT Program

Period	Target	Persons	Specialization	Target	Purpose
36 months	SDSL	6 people	System experts (GIS, IT)	System development,	To foster on- site technical skill in system

				installation and testing	development, installation and test, etc.

6.6. Improvement of the Training Environment Infrastructure

❍ The education and training facility currently used by the SDSL is an old building that was built 50 years ago. The lecture hall and computer room inside the building are in poor condition, making it difficult to provide efficient training. Therefore, there is a need to upgrade the training environment and reinforce the training equipment and materials so as to reinforce the training infrastructure.

❍ Of particular note, two sets of GNSS receivers and controllers related to CORS Network setup were included in the training equipment list.

[Table Ⅴ-77] Improvement of Training Environment and Infrastructure

<table>
<tr><th>Category</th><th colspan="2">Description</th><th>Quantity</th><th>Capacity</th></tr>
<tr><td rowspan="14">Lecture Hall 1
(107 ㎡)</td><td colspan="3">Communications facilities</td><td rowspan="14">50 people</td></tr>
<tr><td rowspan="10">Training equipment</td><td>Workstation*</td><td>1</td></tr>
<tr><td>Desktop</td><td>1</td></tr>
<tr><td>Beam projector</td><td>1</td></tr>
<tr><td>Screen (120 inch)</td><td>1</td></tr>
<tr><td>Electronic desk</td><td>1</td></tr>
<tr><td>Sound system</td><td>1</td></tr>
<tr><td>Whiteboard</td><td>1</td></tr>
<tr><td>Lecture desk</td><td>1</td></tr>
<tr><td>Mobile mic</td><td>1</td></tr>
<tr><td rowspan="3">Furniture</td><td>Desk</td><td>10</td></tr>
<tr><td>Chair</td><td>10</td></tr>
<tr><td>Cabinet</td><td>1</td></tr>
<tr><td rowspan="16">Lecture Hall 2
(162 ㎡)</td><td colspan="3">Communications facilities</td><td rowspan="16">50 people</td></tr>
<tr><td rowspan="11">Training equipment</td><td>Workstation</td><td>1</td></tr>
<tr><td>Desktop</td><td>1</td></tr>
<tr><td>Beam projector</td><td>1</td></tr>
<tr><td>Screen (120 inch)</td><td>1</td></tr>
<tr><td>Electronic desk</td><td>1</td></tr>
<tr><td>Sound system</td><td>1</td></tr>
<tr><td>Whiteboard</td><td>1</td></tr>
<tr><td>Lecture desk</td><td>1</td></tr>
<tr><td>Printer</td><td>1</td></tr>
<tr><td>Plotter</td><td>1</td></tr>
<tr><td>Mobile mic</td><td>1</td></tr>
<tr><td rowspan="3">Furniture</td><td>Desk</td><td>10</td></tr>
<tr><td>Chair</td><td>10</td></tr>
<tr><td>Cabinet</td><td>1</td></tr>
</table>

Category	Description		Quantity	Capacity
	Other	UPS	1	
Lecture Hall 3 (174 ㎡)	Communications facilities			50 people
	Training equipment	Desktop	1	
		Beam projector	1	
		Screen (120 inch)	1	
		Electronic desk	1	
		Sound system	1	
		Whiteboard	1	
		Lecture desk	1	
		Printer	1	
		GNSS receiver and controller	1	
		Mobile mic	1	
	Furniture	Desk	10	
		Chair	10	
		Cabinet	1	
	Other	UPS	1	
Lecture Hall 4 (126 ㎡)	Communications facilities			50 people
	Training equipment	Desktop	1	
		Beam projector	1	
		Screen (120 inch)	1	
		Electronic desk	1	
		Sound system	1	
		Whiteboard	1	
		Lecture desk	1	
		Printer	1	
		GNSS receiver and controller	1	
		Mobile mic	1	
	Furniture	Desk	10	
		Chair	10	
		Cabinet	1	
Computer Room (185 ㎡)	Communications facilities			50 people
	Training equipment	Desktop	1	
		Beam projector	1	
		Screen (120 inch)	1	
		Electronic desk	1	
		Sound system	1	
		Whiteboard	1	
		Lecture desk	1	

Category	Description		Quantity	Capacity
		Printer	1	
		Mobile mic	1	
	Furniture	Desk	10	
		Chair	10	

* 1ea will be installed in SDSL HQ and 2ea will be installed in ISM lecture room at the request of Survery Department of Sri Lanka.

6.7.Organization and Schedule

❍ In the case of capacity building for the Sri Lanka LIS, training is provided separately at the SDSL HQ and the SDSL training center as shown in the following table.

❍ Selection and management of trainees for the training in Korea and training in Sri Lanka a nd customs clearance of training equipment are to be handled by the SDSL headquarters, w hereas the SDSL Training Center is responsible for providing the actual local training and u pgrading training environment infrastructure.

❍ In the case of local training, in particular, a large number of trainees will receive long-term training at the training center; thus, close cooperation with the persons in charge at the SD SL HQ and training center is necessary starting at the time of establishing the training prog ram so that things can run smoothly without any problems.

❍ The organizational structure for the capacity building is as follows:

[Table Ⅴ-78] Capacity Building Program Operating Organization

Affiliation	Persons	Description
SDSL HQ	2	Selection and management (including administrative measures) of trainees for training in Korea (SDSL HQ, district and divisional survey offices, MCs, and related central agencies), etc.
SDSL HQ	8	Selection and management (including administrative measures) of trainees for training in Sri Lanka (SDSL HQ, district and divisional survey offices, MCs, and related central agencies), etc.
SDSL HQ	1	Customs clearance for training equipment for the training center
SDSL training center	4	Field support for local training
SDSL training center	1	Support for training infrastructure setup

7.Consulting Services

7.1.Overview

7.1.1.Service Necessity

- It is necessary to hire professional consultants so that this project can be prepared, executed and operated in an efficient and economical manner and to effectively achieve the overall quality, cost, and construction period targets.

- The SDSL has the ability to manage and operate a land information system, but lacks experience and expertise in establishing and operating integrated data centers. Therefore, consulting services from a group of experts who can set forth the initial direction and implementation strategies of this project and provide technical support are absolutely necessary.

- Consulting services should include basic services for project execution in addition to big preparation and supervision based on a basic design of the project. Data standardization service is urgently needed to lay the groundwork for the project in Sri Lanka as necessary, and capacity building of the project management organization and key personnel prior to the commencement of the project is also essential.

7.1.2.Scope of Consulting Services

- Consulting service includes basic services provided over the course of 12 months, which include basic design and bid preparation support (7 months), contract evaluation and contract support (5 months); bidding; and supervision of the project execution by the selected project implementer over the course of 36 months.

- The main tasks of bid preparation, proposal evaluation and contract support, which are services provided in order to prepare for the project and support the implementation thereof, are as follows:

[Table Ⅴ-79] Consulting Services Period and Their Description

Project stage/period		Description
Basic design and bidding support	7 months	Preparation of bidding documents for database construction, land information system development, data center and infrastructure setup, education and training, and maintenance support Preparation a request for proposal
Proposal evaluation and contract support	5 months	Support for bidding for supplier selection Assistance in evaluation of proposals submitted by bidders and preparation of evaluation reports Contract support according to company selection Support during bidding
Supervision	36 months	Database construction plan and results as well as quality supervision Supervision of installation, unit test and integrated test Purchase equipment for establishing the data centers and infrastructure and check their specifications Review appropriateness of the education and training program Check the maintenance support plan

Project stage/period		Description
		Preparation of process report and completion report (incl. purchasing, progress, quality and payment management)

- Of the consulting services described above, the tasks directly related to the construction pro ject are creating the basic design and performing supervision.

- The basic design task involves establishing an implementation plan for the database, system, ICT infrastructure, and capacity building for 4 months at the beginning of the consulting s ervices, and supervision involves inspecting and evaluating the quality of project outputs for each stage during the 36 months of the construction project.

- The main tasks in each area are as follows:

[Table Ⅴ-80] Main Details of Basic Design Services by Area

Project area	Description
Database	Perform a field survey, basic data collection, and environmental analysis for database construction Determined how many cadastral databases need to be built: a complete survey of one local office and interviews and questionnaire-based surveys for other regions Establish input procedure and method by status/type Define data entry standards in connection with standardization work Analyze the requirements and related laws and systems Analyze related capacity and technical level Analyze human resources, equipment and technical level for data input and propose measures Design system operation and set forth a maintenance plan and a database update plan
LIS	Perform a survey and analysis of the related work and analyze the system operating environment Prepare specifications of system functions and application architecture Analyze the requirements and related laws and systems Analyze related capacity and technical level Design system operation and set forth a maintenance plan and a database update plan
Data center and operating infrastructure	Create a data center design and facility layout plan Perform an infrastructure status analysis Determine the quantity and specifications of hardware needed at the main data center and backup center Set forth a purchase and installation plan (schedule, customs clearance, transportation) Analyze the requirements, related laws and systems, and policies Analyze related capacity and technical level Create an operating plan (financial resources and personnel) and maintenance and repair plan
Capacity building	Carry out a diagnosis of the skill and knowledge level and an analysis of the SDSL training program and training status Develop training programs to be administered in Korea and Sri Lanka, analyze

Project area		Description
		the target persons for training, and establish an implementation plan Establish a lecture hall operation plan for local training Establish a plan for improving the training environment and infrastructure and create a schedule for customs clearance, transportation and installation of training equipment
	PMU training	Training project management unit (PMU) and local staff training - Project management, ISP Training - Basic training on LIS/GIS/ DBMS and ICT administration training - Training of local project managers Use the consultants as much as possible and have them participate (OJT) in the PMU consulting services to build capacity

- The supervision work includes quarterly inspections and interim and final supervision.
- A single inspection involves two weeks of stay in Sri Lanka as well as two weeks of work in Korea for preparing for the business trip and inspection and organizing the inspected matters.
- The supervisory personnel will be composed of experts from each field. Based on the outputs during the supervision period, the supervision of the LIS and ICT infrastructure will be conducted according to the information system supervision standards, while the supervision of the cadastral database setup will be carried out by the experts through direct surveying and visual inspection to determine the quality of the outcomes.

[Table Ⅴ-81] Main Details of Supervision by Field

Field	Details
Project management	Inspection of processes and progress management Inspection of risk management Inspection of issue management Inspection of manpower management Inspection of purchase/procurement management
Database	Inspection of compliance with work instructions Inspection of final outputs by region and phase Inspection of drone image quality, image processing quality, accuracy, and work performance procedure
System	Inspection of the system survey analysis report and detailed design Inspection of system development, construction, installation, unit test and integrated test Inspection of outputs according to the construction methodology by system Review and supervision of operation and maintenance support plan Preparation of a process report and completion report (incl. purchase, progress, quality, payment, management, etc.)
Data center and operating infrastructure	Inspection of hardware and software purchase plans Inspection of the purchase, installation, unit test, acquisition and integration test Review and supervision of operation and maintenance support plan Preparation of a process report and completion report (incl. purchase, progress, quality, payment, management, etc.)
Capacity building	Supervision of training plan and program Curriculum review and monitoring and supervision of training results Review of operation and maintenance support plan

Field	Details
	Preparation of a process report and completion report (incl. purchase, progress, quality, payment, management, etc.)

7.2.Consultant Assignment Plan

7.2.1.Consultant Group Composition

❍ The consulting services of this project will be divided into three stages, with a group of ex perts assigned to the main areas of the project such as database, system, data center and IC T infrastructure, and capacity building.

❍ The first stage can be divided into preparation of basic design and bidding documents, the s econd stage into proposal evaluation and contract support, and the third stage into supervisi on of construction work. The group of consultants that will provide such consulting services is composed as follows:

[Table Ⅴ-82] Composition of Experts for Consulting Services

Phase		Personnel(M/M)			Key work details
		Grade	Foreign Expert	Local Expert	
Phase 1	Site survey, basic design, preparation of RFP	Special	38.00	11.00	Basic design and RFP preparation on the field of CORS construction, mapping digitalization, UAV surveying, spatial DB, land management system and data center
		Advanced	30.00	-	- Basic design and RFP preparation on land administration system, IT network, capacity building -Project management
Phase 2	Support in proposal evaluation and contract negotiation	Special	20.75	-	Support in evaluating the proposal and contract negotiating on the field of the construction of CORS, mapping digitalization, UAV surveying, spatial DB, land management system and data center
		Advanced	7.00	-	- Support in evaluating the proposal on capacity building - Project management
Phase 3	Supervision	Special	63.00	36.00	Supervision on the construction of CORS, mapping digitalization, UAV surveying, spatial DB, land management system and data center
		Advanced	69.00	-	- Supervision on capacity building - Project management

7.2.2.Selection of Consultants

❍ The consulting firm selection period is three months, and this is in adherence to the EDCF pu rchasing guidelines of the Korea Export-Import Bank. In addition, it is necessary to present pr oper procedures to the project implementer so that all purchasing procedures comply with the "EDCF purchasing guidelines" and to coordinate the opinions between the two entities.

8.Maintenance and Repair Support Plan

8.1.Maintenance and Repair Support Types and Periods

8.1.1.Types of Operation and Maintenance

❍ The types of operation and maintenance and details thereof are as follows:

[Table Ⅴ-83] Details of Operation and Maintenance

Classification	Description	Type of support
Corrective maintenance (for defects)	Errors and inconsistencies with the specification Inappropriate information output Transaction error Inconsistencies in the functional specifications and designs Abnormal termination of the program Other functional defects	Free maintenance
Adaptive maintenance	Maintenance performed for the system to be used in a different environment when changing the system according to the changes in the operating environment and related laws Change of classification code and database within design scope System monitoring and reflecting requests/demands from the staff Tuning of functions and modules specified in the project contract	Charged, after free maintenance period
Functional modification and expansion	Maintenance performed in case of performance improvement factors arise due to new technology Structural adjustment of software Scaling of system functions Changing to higher spec hardware model when upgrading system version Construction of additional databases	Performed in accordance with the maintenance contract

8.1.2.Maintenance and Repair Period

❍ Stable maintenance support and technical support are essential for smooth operation of the s ystem, and various types of technical support and stabilization activities of the maintenance team are crucial.

- The contractor provides a 2-year warranty for the system equipment delivered after system setup
- However, the 2-year warranty for the equipment and equipment initially delivered early on for digitization of drawings and terriers/ledgers will start on the equipment delivery date.
- A maintenance system is established to systematically respond to the rapidly changing information technology by conducting preventive inspections in advance and preparing the necessary measures to respond immediately to any failures.

8.2.Operation and Maintenance Support Measures

❍ The system operation and maintenance (O&M) organization for this project will run for a limited period of two years. Maximum duration of participation in maintenance should be ensured for those who participate in system development by using an open source development engine so that difficulties arising from unexpected risks and unskilled/inexperienced system operation in the early stages can be mitigated as much as possible. The maintenance personnel will be composed as follows:

[Table Ⅴ-84] Maintenance and Management Organization Composition

<table>
<tr><th colspan="2" rowspan="2">Category</th><th rowspan="2">Type of experts</th><th colspan="2">Input period</th><th rowspan="2">Description</th></tr>
<tr><th>Korea</th><th>Local</th></tr>
<tr><td rowspan="6">Concentrated support for stabilizing system operation (resident experts from each field)</td><td rowspan="3">Stage 1 (6 months)</td><td>System developer</td><td>3 people, 6 months</td><td rowspan="10">2 local experts from each field supported for 24 months</td><td rowspan="6">Have experts on site to support system operation, maintenance and repair, system stabilization, user training, troubleshooting, operation advancement, etc.</td></tr>
<tr><td>Database expert</td><td>3 people, 6 months</td></tr>
<tr><td>Center and infrastructure construction expert</td><td>2 persons, 6 months</td></tr>
<tr><td rowspan="3">Stage 2 (3 months)</td><td>System developer</td><td>2 people, 3 months</td></tr>
<tr><td>Database expert</td><td>2 people, 3 months</td></tr>
<tr><td>Center and infrastructure construction expert</td><td>2 person, 6 months (Shift)</td></tr>
<tr><td colspan="2" rowspan="2">Stage 3: 3 months
Direct support for maintenance and repair purposes (minimum number of external experts residing at the office)</td><td>System developer</td><td>1 person, 3 months</td><td rowspan="2">Consulting on user training, troubleshooting, operation support enhancement and increased scope of functions</td></tr>
<tr><td>Center and infrastructure construction expert</td><td>2 person, 6 months (Shift)</td></tr>
<tr><td colspan="2" rowspan="2">Stage 4: 12 months
Indirect support via remote support</td><td>System developer</td><td>1 person, 12 months</td><td rowspan="2">Crisis response, troubleshooting, technical support, system advancement support</td></tr>
<tr><td>Center and infrastructure construction expert</td><td>2 person, 6 months</td></tr>
</table>

8.2.1.LAS and LISS

❍ Systematic maintenance activities need to be maintained for two years (24 months) after conducting inspection at the time of completing the construction in order to ensure stable operation and operating efficiency of the Sri Lanka land information management system by ensuring stability and business continuity and setting up an emergency preparedness system an d immediate response system for failures.

❍ In order to support the smooth maintenance of the system, the SDSL should establish a maintenance support team that can mobilize Sri Lankan users and the personnel of specialized partners. The operation and maintenance (O&M) support team created by the contractor should be operated for a residency period (12 months) and a non-residency period (12 months) to provide stable operational support, perform preventive maintenance on a regular basis, and ensure efficient implementation of emergency measures and response to failures.

[Table Ⅴ-85] Operation and Maintenance Support Measures (LAS and LISS)

<table>
<tr><th rowspan="2">Stage 1</th><th rowspan="2">Period</th><th colspan="2">Personnel</th><th rowspan="2">Description</th></tr>
<tr><th>Domestic technicians</th><th>Local personnel</th></tr>
<tr><td>Stage 1</td><td>6 months after the project</td><td>Special Class: 1. Advanced: 2</td><td rowspan="5">people 2</td><td rowspan="3">- Repair of defects: This is a case of finding the cause of a problem to solve the problem. This service is provided free of charge within the warranty period, but fees are charged afterwards. Services include troubleshooting problems with the application program, fixing defects, and fixing functional errors in the application program.
- Functional improvement: This is a case of adding new function and improving the existing system, and such measures are taken after consultation. It is performed to reflect the user demands/requirements and the changes in the required functions due to amended regulations or changes in the systems or business processes.
- Environmental application: This is to set up a new operating system or transplant the system into a new hardware environment for a prescribed fee.
- Preventive measures: This is to improve the ease of maintenance and repair or improve system reliability, and this service is provided free of charge.
- Inspection support: This involves system operation management, training support, and preventive inspection of system software at every stage</td></tr>
<tr><td>Stage 2</td><td>3 months after Stage 1</td><td>Special Class: 1. Advanced: 1</td></tr>
<tr><td>Stage 3</td><td>3 months after Stage 2</td><td>Advanced: 1</td></tr>
<tr><td rowspan="2">Stage 4</td><td rowspan="2">12 months after Stage 3</td><td rowspan="2">Advanced: 1 Remote support</td><td>- Support call center operations, meet requirements, answer inquiries, and implement crisis response</td></tr>
<tr><td>- Collaboration with Korean experts (support)
- Joint use of operating support application system, data center and infrastructure maintenance and repair support</td></tr>
</table>

❍ The target of system maintenance is confined to the application system functions in operation after the completion of the development process, and does not include the hardware and software. It also includes troubleshooting problems/failures and technical support for proper operation of the system. The maintenance services are divided into free services and charged services.

[Table Ⅴ-86] Scope of Free Maintenance and Repair

Category	Scope of support
Repair period	• The warranty period for free repairs of the delivered item (application system function) is 12 months (1 year) from the inspection date.
Scope of repair	• Functional problems (excl. failures caused by hardware and software) concerning any of the application systems prescribed in the list supplied at the completion of this project • Technical defects, non-conforming performance or underperformance, frequent failures, process failures (errors); • Any mechanical defects and omission of required functions occurring within the warrant period, except for problems caused by user negligence or natural disaster
Support	• Correction, supplementation, reinstallation and testing of functions that may potentially fail, system status analysis, configuration optimization, and training for each area
Exceptions	• As for support provided for system failures caused by natural disaster or user negligence, dispatch of personnel from departments unrelated to system operation, technical support, and equipment transfer, decisions should be made after consulting the user

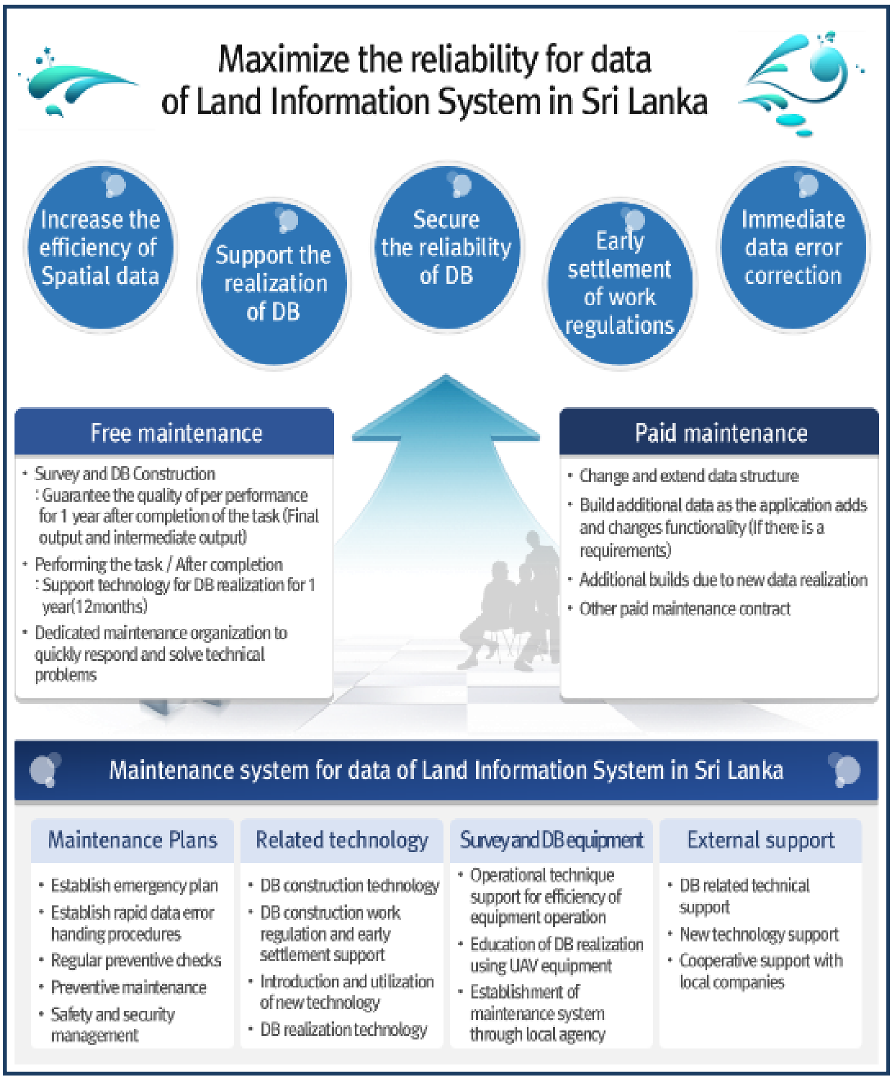
[Table Ⅴ-87] Scope of Charged Maintenance and Repair

Repair period	Scope of support
Repair period	• After the warranty period
Scope of repair	• Design change to improve performance such as addition of new functions, system installation for scaling and changes to hardware and database • Damage caused by natural disaster or user negligence and services involving software subject to charged maintenance according to the software vendor policy • Other matters not included in the free maintenance and repair services
Support	• In the case of charged maintenance and repair, the scope and cost are determined by consulting with the project implementer

8.2.2.Land and Spatial Information DB

❍ In the case of land and spatial information DB to ensure the stability and utility of the Sri Lanka LIS, maintenance activities will be carried out based on the aim of “maximizing data efficiency,” “ensuring database reliability,” “preparing operating regulations and early establishment thereof,” “DB currentization support,” and “immediately handling data errors.”

❍ The maintenance plan for land and spatial information DB is as follows:



[Figure Ⅴ-45] Maintenance Plan for Land and Spatial Information DB

❍ Primary maintenance activities consist of immediate response and correction of data errors, which may occur despite having performed inspections such as self-inspections during the d atabase construction process and inspections by the supervisor.

❍ The secondary maintenance activities consist of keeping the database up-to-date for the purp ose of ensuring that the database construction work regulations, which will be prepared by consulting with SDSL, and the related technologies will become established in the early sta ges.

❍ The primary and secondary maintenance activities are included in the scope of work of the contractor, and are carried out during the initial 12 months of residence after the completio n of the project.

❍ The third maintenance activity is to remotely support the DB update technology built throug h this project, rather than additional construction, and is carried out during the second year maintenance period.

- The maintenance activities of land and spatial information DB will continue for 24 months (2 years) after the completion inspection, and the O&M support team from the contractor will immediately respond to errors and keep the database current during a residency period (12 months) and non-residency period (12 months).

- Maintenance of the equipment provided for construction of land and spatial information DB will be carried out as either free maintenance and charged maintenance in cooperation with the local maintenance agency. Free maintenance is defined according to the maintenance policy of the manufacturer of the equipment that has been supplied.

8.2.3.Data Center and Operating Infrastructure

1) Target and Scope of Maintenance Support

- Support for maintenance of the data center and infrastructure construction projects for the Sri Lanka LIS is confined to the network equipment, server systems, and facility equipment provided by the contractor, and the maintenance and repair period consists of Six(6) Months resident maintenance period, One(1)-year shift work and Six(6)-months remote support period.

- The scope of the maintenance support provided includes hardware after-sales services, software upgrades, and troubleshooting for the systems supplied to and installed at the main data center at the SDSL headquarters, backup data center at the SLT and NDC, 25 district survey offices and 84 divisional survey offices.

- The detailed targets and scope of maintenance by level are as follows:

[Table Ⅴ-88] Targets and Scope of Infrastructure Maintenance

Level	Item	Targets and scope of maintenance
Main Data Center (SDSL HQ)	Network	Backbone Switch, L2 Switch
	Security	DDoS, IPS, Firewall, Web Firewall, Access Control, NMS/SMS/FMS, ESM, Vaccine
	Server and Storage	Web/WAS Server, DB Server, GIS Server, Backup Server and S/W, Data Connection Server, Development DB Server, Web/WAS Development Server, SSO Server and S/W, SAN Switch, Storage
	Infrastructure	UPS, Thermo-Hygrostat, Firefighting Equipment, CCTV System and Access Control System
Backup Data Center (SLT IDC)	Network	Backbone Switch, L4 Switch, L2 Switch
	Security	DDoS, IPS, Firewall, Web Firewall, Access Control, NMS/SMS/FMS, ESM, Vaccine
	Server and Storage	Web/WAS Server, DB Server, GIS Server, Backup Server and S/W, VTL, Data Linked Server, SAN Switch, Storage
District survey offices (25 locations)	Network and Security	L2 Switch, Vaccine
	Hardware	Workstation for preparing/reviewing cadastral system

Level	Item	Targets and scope of maintenance
Divisional survey offices (84 locations)	Network and Security	L2 Switch, Firewall
	Infrastructure	Rack Mountable UPS and Housing Case
MC (24 locations)	Hardware	LAS Access Client(PC)

- ❍ The warranty period for above products is three years, including one year of construction and two years of O & M support, after the Project completion. After the warranty period, it is expected approximately 12% of the total equipment cost will occur as annual maintenance costs.

2) Operation and Maintenance Support Measures

- ❍ The Sri Lanka LIS data center and infrastructure construction company must establish detailed maintenance support measures as follows:
  - – Store modules and products that are of the main equipment or associated with high failure frequency at a certain rate
  - – Establish a plan to utilize local suppliers from the beginning of the construction project for speedy response in case of failure
  - – Prepare a local after-sales service system and a support system with service providers in neighboring countries in the case of products manufactured by a global vendor
  - – Establish a system that enables smooth cooperation between the resident maintenance personnel and the equipment vendors
  - – Enhance IT competency by involving the local staff in the project starting at the time of building the land data infrastructure system

- ❍ The plan for mobilizing manpower for maintenance and repair in the Sri Lanka LIS data center and infrastructure construction project is as follows:
  - – Considering the failures that may occur in the early stages after the completion of the LIS construction, IT specialists should stay in the SDSL HQ for Six(6) Months and conduct the concentrated support period, One(1) Year shift work and then provide remote support for Six(6) Months thereafter.
  - – Two(2) specialists in total: One(1) Network and Hardware specialist and One(1) Information Security Facility specialist

[Table Ⅴ-89] Infrastructure Maintenance Personnel Plan

Category	Detailed tasks
Common	Preventive inspection and maintenance for each equipment Troubleshooting and technical support in case of failure
Network and server specialist	Network equipment and server, Storage, Backup system management Equipment operation and local staff training

Category	Detailed tasks
Information security facility specialist	Security system management Equipment operation and local staff training

8.3.Operational Spare Part Lists

- Operational Spare Parts support for the Sri Lanka LIS is aimed at ensuring stable operation of the LIS by having sufficient spare supplies when it comes to major equipment, modules and parts in order to maintain and repair IT infrastructure system as quickly as possible in case of failure and damage.

- The budget allocated for Operational Spare Parts for each system is 2% of the ICT infrastr ucture budget(excluding the Cost for installation and Test), based on the other EDCF pr ojects.

- The selection criteria for Operational Spare Parts focused on the failure frequency and level of importance of the system.

- The company hired to build the system must provide the following Operational Spare Parts based on the reserve supplies selection criteria. Specific details will be determined by the c onsultants to ensure efficient budget execution.

[Table Ⅴ-90] Measures for Providing Operational Spare Parts

Category	Operational Spare Parts
Network/Security	Main Process Module, Interface Module, Power Module, L2 Switch, UTM, 1G SFP Transceiver, etc
Server/Storage	HDD, Memory, NIC Card, HBA Card, SFC Card for Storage, etc
Infrastructure	UPS, Circuit breaker, Cooling fan, Fuse, Main Parts of Firefighting Equipment, Main Parts of Thermo-Hygrostat, CCTV, etc

8.4.O&M plan

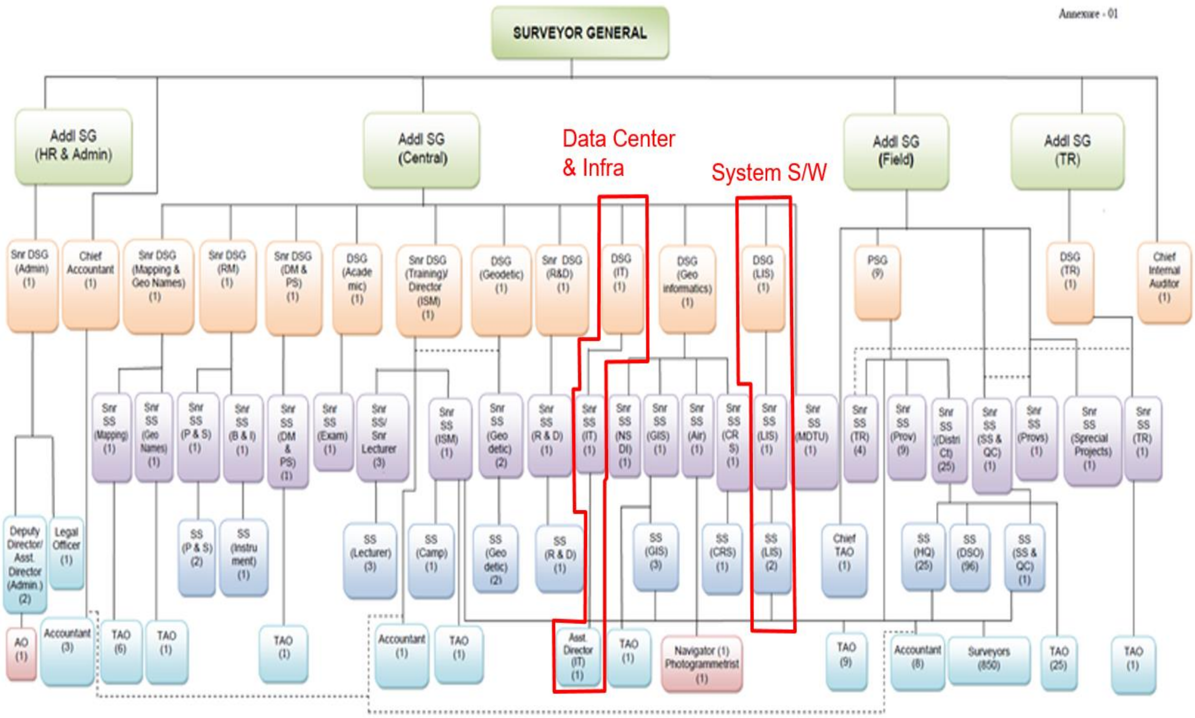
8.4.1.Organization of O&M

- After the completion of main project, the project management plan is presented for smooth operation and management of the SDSL

- For the practical operation, it is divided into operational organization composition, manpowe r supply plan, system operation and management plan, and financing plan for practical oper ation.

- Since the SDSL, which is implementation agency for the project, has already an LIS divisio n in charge of LAS and LISS and an IT division that supports the maintenance of compute rized equipment, it does not suggest to form a separate organization utilize existing sub-org anizations of each division

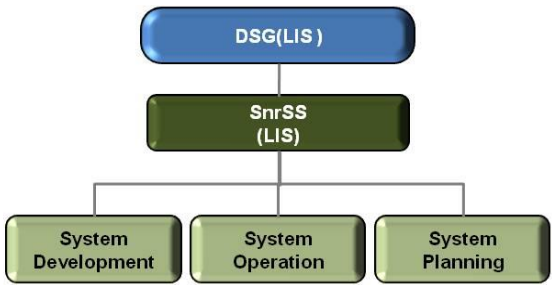
❍ The Database construction part can be operated and maintained by the existing SDSL headquarter and regional offices, so no separate organization is required



[Figure V- 46] Proposal of composition for O&M

1) LIS Organization(Supplement)

❍ O&M organization for LIS and composition is as follows:



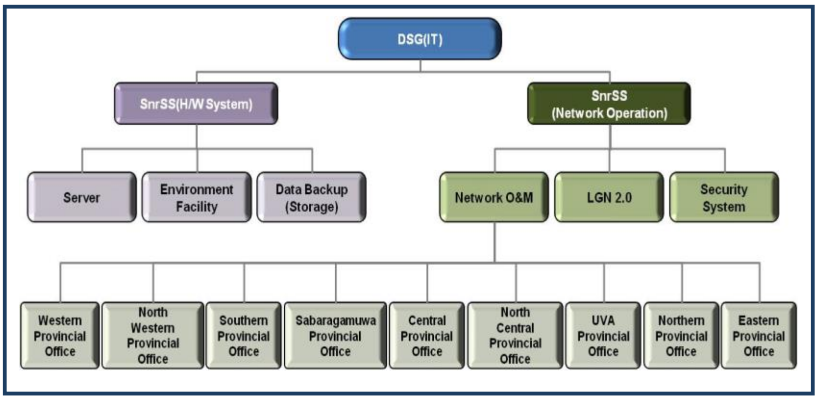
[Figure V- 47] O&M organization for LIS

[Table Ⅴ-91] Composition for O&M organization

Categories		Grade		Total NO. of people
		Special	advanced	
Manager(DSG-LIS)		(1)		(1)
S/W System	Tech Leader (Snr.SS)	(1)		(1)
	System Planning		2	2
	System Operation		2	2

	System Development		2	2
Total		(2)	6	6(2)

2) IT Organization(Supplement)



[Figure Ⅴ-48] O&M Organization for ICT

❍ The personnel and technician class for each field are planned as follows:

[Table Ⅴ-92] ICT Operating Personnel Organization

Area			Grade(*) : Existing				Total Manpower Export
			Expert	High	Middle	Low	
Manager(DSG-IT)			(1)				(1)
H/W System	Server Management(Snr.SS)			1	(1)		1(1)
	Environment Management				(1)	(1)	(2)
	Data Backup			1			1
Network Operation	LGN 2.0				1		1
	Security System Management				1	1	2
	Network O&M (Snr.SS)			1		1	2
		Western Province			1		1
		North Western Province			1		1
		Southern Province			1		1
		Sabaragamuwa Province			1		1
		Central Province			1		1
		North Central Province			1		1
		UVA Province			1		1
		Northern Province			1		1

Area			Grade(*) : Existing				Total Manpower Export
			Expert	High	Middle	Low	
		Eastern Province			1		1
Total			(1)	3	11(2)	2(1)	16(4)

8.4.2.Operational Cost

- Operational costs such as labor, system maintenance, building management, and electricity b ills after the construction of LAS and LISS and Data Center are responsible by the Sri Lan kan Government and Surveying Department (SDSL)

[Table Ⅴ-93] Operational Cost (Base Cost)

Item	Annual expected Cost (USD)	Description
Labor	269,874	Average Wage in Public Sector
System maintenance	1,789,200	Update and Maintenance cost 12% of System Construction cost(H/W & S/W)
IDC Rental	83,448	Annual payment for SLT IDC Space
Utility Cost	46,000	General expenses including electricity, water and gas
Total	2,188,522	

[Table Ⅴ-94] Expected Annual Operational Cost

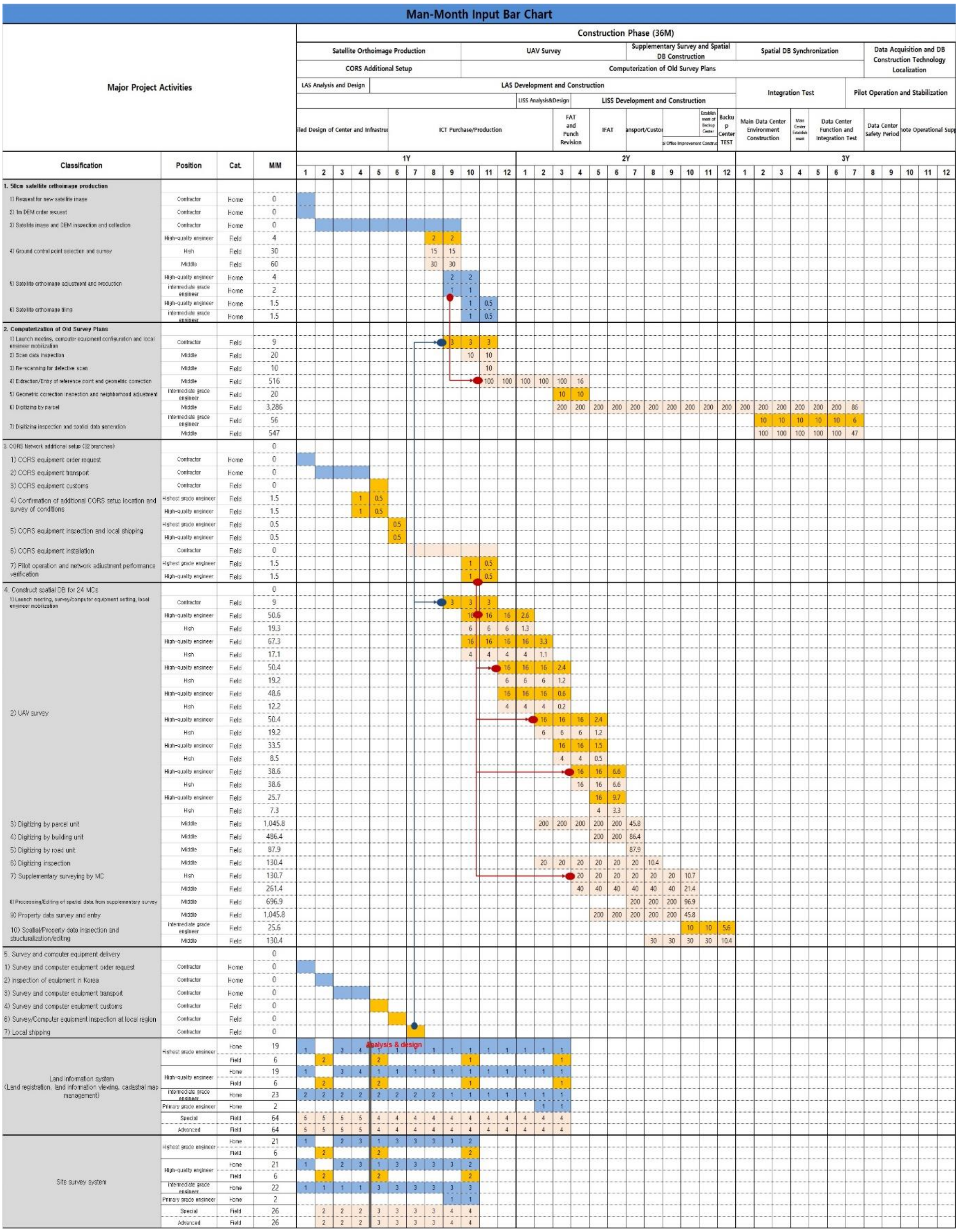
(Unit: 1,000 USD)

Title	Y1	Y2	Y3	Y4	Y5
Annual Operational Cost	2,189	3,068	3,220	3,380	3,547

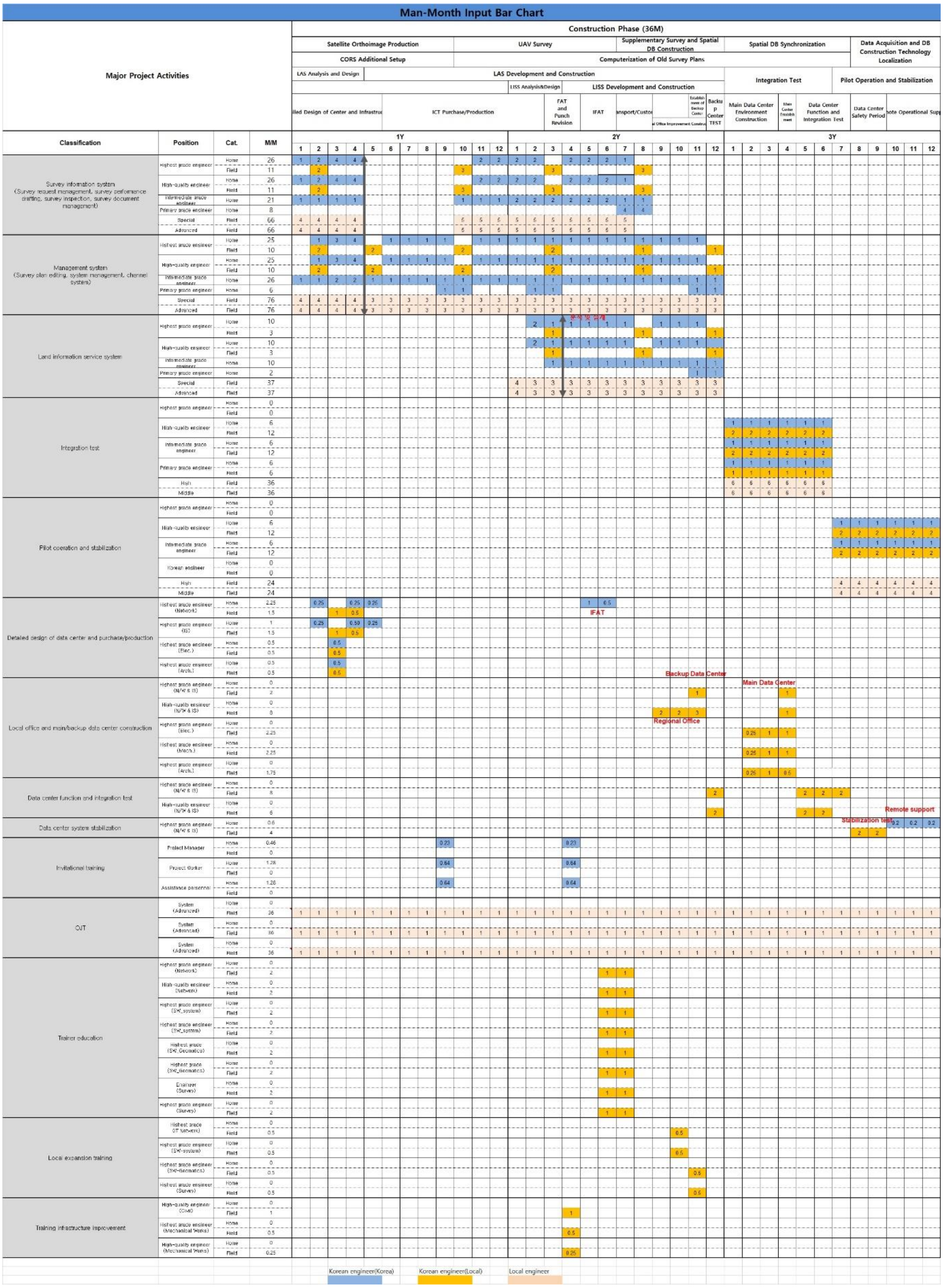
Based on the Economic Feasibility Analysis Criteria for EDCF Projects, a 9% discount rate was applied in this economic feasibility analysis.
In this feasibility study, the inflation rate that was applied was 4.95%, and this was the average inflation rate (unit: percentage change) in Sri Lanka from 2016 to 2018, determined by the IMF

9. Maintenance Schedule

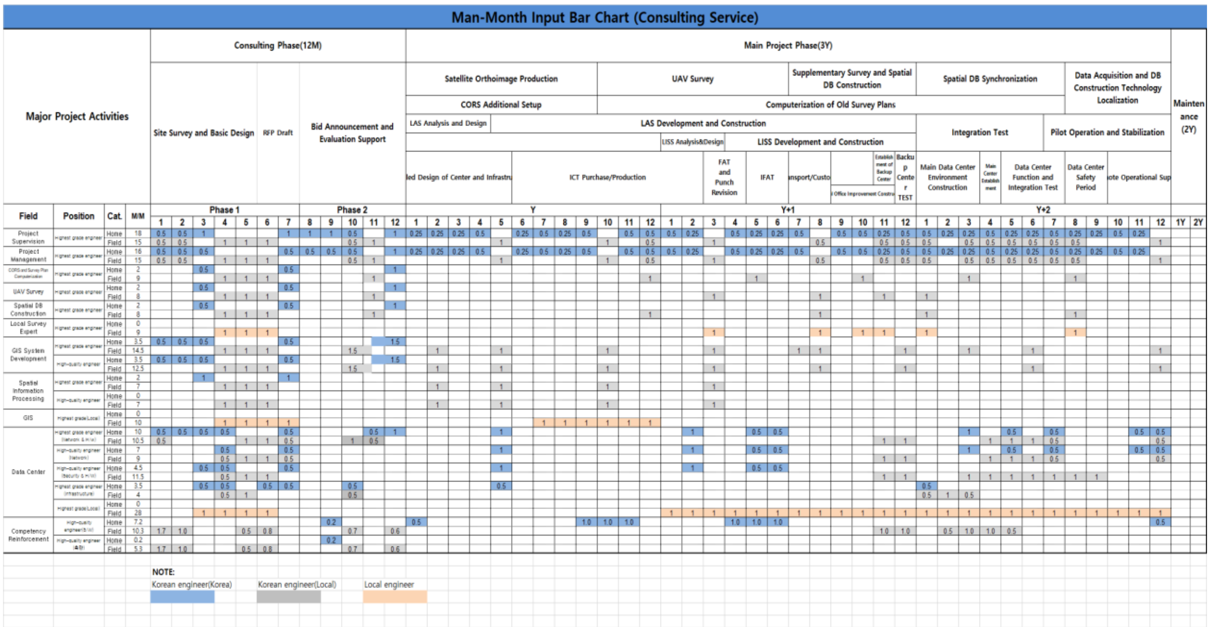
- The schedule and human resources input plan of this project are divided into project executi on, consulting service, operation and maintenance. For detailed schedule and human resourc es input plan, refer to the figure below.



[Figure Ⅴ-49] Project detailed schedule and manpower input plan (A)



[Figure Ⅴ-50] Project detailed schedule and manpower input plan (B)



[Figure Ⅴ-51] Consulting service detailed schedule and manpower input plan (B)

Man-Month Input Bar Chart (Maintenance)

Major Project Activities					Main Project(4Y)				Maintenance(2Y)																							
					Consulting+Main Project				1st Year												2nd Year											
					2021-2024				2025												2026											
Classification	Field	Position	Cat.	M/M	1Y	2Y	3Y	4Y	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Operational Stabilization Focused Support	CORS and mapping computerization	Highest grade engineer	Home	0																												
			Field	3					1	1	1																					
	UAV survey	Highest grade engineer	Home	0																												
			Field	3					1	1	1																					
	Spatial DB construction	Highest grade engineer	Home	0																												
			Field	3					1	1	1																					
	Local survey expert	Highest grade(Local)	Home	0																												
			Field	6					1	1	1	1	1	1																		
	System development	Highest grade engineer	Home	0																												
			Field	6					1	1	1	1	1	1																		
		High-quality engineer	Home	0																												
			Field	12					2	2	2	2	2	2																		
	GIS	Highest grade(Local)	Home	0																												
			Field	24					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	N/W & H/W	Highest grade engineer	Home	0																												
			Field	6					1	1	1	1	1	1																		
	Information Security	Highest grade engineer	Home	0																												
			Field	6					1	1	1	1	1	1																		
General Support for Operational Stabilization	UAV survey	High-quality engineer	Home	0																												
			Field	6											1	1	1	1	1	1												
	Spatial DB construction	High-quality engineer	Home	0																												
			Field	6											1	1	1	1	1	1												
	System development	Highest grade engineer	Home	0																												
			Field	3											1	1	1															
		High-quality engineer	Home	0																												
			Field	3											1	1	1															
	N/W & H/W	Highest grade engineer	Home	0																												
			Field	3														1	1	1												
	Information Security	Highest grade engineer	Home	0																												
			Field	3											1	1	1															
Competency Reinforcement	GNSS CORS	High-quality engineer	Home	0																												
			Field	2								0.5					0.5							0.5					0.5			
	UAV survey	High-quality engineer	Home	0																												
			Field	2								0.5					0.5							0.5					0.5			
	DB/engine/server/integration	High-quality engineer	Home	0																												
			Field	2								0.5					0.5							0.5					0.5			
	Application program/web service	High-quality engineer	Home	0																												
			Field	2								0.5					0.5							0.5					0.5			
	Network	High-quality engineer	Home	0																												
			Field	2								0.5					0.5							0.5					0.5			
	Security	High-quality engineer	Home	0																												
			Field	2								0.5					0.5							0.5					0.5			
Indirect Operational Support	Spatial DB construction	High-quality engineer	Home	0																												
			Field	0																												
	System development	High-quality engineer	Home	0																												
			Field	3														1	1	1												
	N/W & H/W	Highest grade engineer	Home	1																					1							
			Field	2																				1		1						
	Information Security	Highest grade engineer	Home	2																	1		1									
			Field	1																		1										
Remote Operational Support	Spatial DB construction	High-quality engineer	Home	0																												
			Field	0																												
	System development	High-quality engineer	Home	0																												
			Field	4.5																	0.5	0.5	0.5	0.5	0.5	0.5	0.25	0.25	0.25	0.25	0.25	0.25
	N/W & H/W	Highest grade engineer	Home	1.5																							0.25	0.25	0.25	0.25	0.25	0.25
			Field	0																												
	Information Security	Highest grade engineer	Home	1.5																							0.25	0.25	0.25	0.25	0.25	0.25
			Field	0																												

NOTE:
Korean engineer(Korea) Korean engineer(Local) Local engineer

[FigureⅤ-52] operation and maintenance detailed schedule and manpower input plan (B)

- The main components of the project are ① construction of spatial information, ② system d evelopment, ③ data center and information infrastructure construction, ④ education and ca pacity building, and for executing the project, ⑤ consulting services and ⑥ operation and maintenance work is included.

9.1.Execution Schedule by General / Sector / Year

- Detailed tasks for constructing spatial information include: ⑴Computerization of the old sur vey plan, ⑵ Acquisition of spatial information for 24 major councils using UAV, ⑶ Install ation of 32 GNSS CORS base stations and network configuration, ⑷ Produce 50cm resolut ion satellite ortho image and ⑸ purchase survey and computer equipment.

– When the project starts, ⒜ Install GNSS CORS Base Station (M1-M11), ⒝ Produce Satellite Ortho Image (M1-M11), and purchase Survey and Computing Equipment (M1-M7) simultaneously.

– After the delivery of the equipment is completed, simultaneously start ⒜ the computerization of old survey drawings (M9-M31) and ⒝ the acquisition of 24 MC aerial images (M9-M18) using UAV.

  • Spatial information acquisition (M13-M24) for 24 MCs should be performed in sequence starting from the area where aerial orthodontic image acquisition is completed.

- The detailed task of system development is composed of ⑴ Land Administration System (LA S) and lower 8 modules and ⑵ Land Information Service System (LISS) and lower 3 module s.

– Once the project is undertaken, both Korea and Sri Lanka will start at the same time, ⒜ a total of 24 months of system development (M1-M24) will be proceeded, ⒝ 6 months of integrated testing (M25-M30) and ⒞ 6 months of pilot operation and stabilization will be proceeded to complete the task.

- The detailed tasks of Construction for Data Center and Infrastructure are divided into: ⑴ Constructing Main D / C, ⑵ Constructing Backup D / C, and ⑶ Comprised of improvi ng the computing environment for 24 locations of District Survey Office (DistSO) and 84 l ocations of Division Survey Office.

– At the initial stage, conducted the detailed design(M2-M5) of the Data Center and proceeded the procurement and fabrication of related equipment(M6-M20).

– Establish main and backup data centers and improve computer environment of local survey office (M21-M31)

  • Build a backup data center (M21-M23) and conduct functional tests (M24)

  • Build a main data center (M26-M28) and conduct functional tests (M29-M31)

– Data center function stabilization (M32-M33) and remote support pilot operation (M34-M36)

❍ The detailed tasks of education and capacity building are mainly (1) Korea invited training, (2) Local education and training, (3) On the Job Training (OJT) for operation and maintenan ce, (4) Improving Education Environment for Survey Office education center.

– Invited training sessions in Korea are held twice, two weeks each (M10, M17)

– Local education and training is divided into (a)training instructor (M18-M19) and (b) training of local professional expert (M22-23).

– In-depth practice training consists of 6 months of training and 30 months of development practice with local partners.

– Improvement of educational environment consists of improvement of lecture hall facilities (M16) and implementing computerized equipment and surveying equipment.

❍ Consulting services consist of (1) preparing a Request for Proposal (RFP), (2) selecting a co mpany and supporting contracts, and (3) supervising the project.

– Preparation of Request for Proposal (RFP) is divided into on-site inspection and basic design (P1.M1-P1.M5) stage and proposal request preparation (P1.M6-P1.M7) stage.

– The selection of operators and contract support are divided into proposal evaluation and selection of operators (P2.M8-P2.M10) and technical negotiation and contract conclusion (P2.M11-P2.M12).

– The supervision of the project will be conducted for a total of 36 months, and project management (overall / management) reviews monthly reports and checks the progress on a quarterly basis.

• For the first 18 months, local business trip will be held once for 6 months, and later on the quality of the project will be enhanced by increasing the number of times instead of shortening the length of the visit.

❍ Operation and maintenance will be conducted for two years after the completion of the proj ect, and are divided into (1) operation stability support, (2) capacity building / supplementar y training, (3) operation support and remote support.

– Operational stabilization support is divided into intensive support (OM.M1-OM.M6) period and general support (OM.M7-OM.M12) period.

– Capacity building and supplementary training will be given to local experts four times each (OM.M4, OM.M9, OM.M16, OM.M21) for two weeks each.

– Operational support and remote support should be appropriately overlapped with indirect operation support (OM.M10-OM.M18) and remote support (OM.M13-OM.M24).

• Transfer of authority to local experts in phases, for local experts to directly operate and maintain the project.

9.2.HR input Plan

❍ Establish spatial information

– Cross deployment of Korean and local experts at each stage for computerization of existing survey drawings

- Computer equipment preparation (3 persons / 3 months), geometric correction inspection and adjacent adjustment (intermediate 10 persons / 2 months)
- Scan data inspection (10 persons / 2 months), bad data rescanning (10 persons / 1 month), reference point extraction and geometric correction (100 persons / 5.2 months), digitizing (200 persons / 16.5 months) local intermediate technicians
- Digitizing inspection and spatial data generation, involve Korean workers (intermediate 10 persons / 5.6 months) and local intermediate technicians (100 persons / 5.5 months) simultaneously.

– GNSS CORS base station installation will be sub-contracted using turn-key method

- Input short-term (3.5 months each) one specialized technician and one advanced technician

– Satellite ortho-image production consists of ground control point survey, orthodontic correction, normal image production, and tiling.

- Temporarily input short-term (two months each) of two advanced technicians and local advanced and medium leveled local technicians to the ground reference point survey
- Temporarily input short-term (two months each) two advanced technicians and one intermediate technician for orthodontic correction and normal image production
- Temporarily input short-term (1.5 months each) for one advanced technician and one intermediate technician for tiling correction images

– Acquisition of aerial MC images using 24 UAVs simultaneously

- UAV survey involves 64 Korean advanced technicians (5.7 months each) and 20 local advanced engineers (7.1 months each) sequentially.
- Digitizing by object should be carried out simultaneously in parallel with parcels (intermediate 200 people / 5.5 months), buildings (intermediate 200 people / 2.8 months), and roads (intermediate 100 people/ 0.9 months) with local personnel.
- Digitizing inspection (intermediate 20 people / 6.5 months) is conducted with local personnel.
- Complementary survey should be conducted for 6.5 months using local high-level (20 people) and intermediate (40 people) technical personnel.
- Spatial data processing and editing should be conducted for 4 months using local intermediate (200 people) technical personnel.
- Investigate and input attribute data for 5.5 months with local intermediate (200 people) technical personnel
- Spatial / property data inspection and structured editing input Korean personnel (intermediate 10 people/ 2.6 months) and local intermediate technical personnel (30 people / 4.4 months) simultaneously

❍ System development proceeds with the development of land registration system (LAS) and l and information service system (LISS).

– Korean developers and local developers will collaborate for the development of a land registration system (LAS).

- (Korea) Specialized Technician (Korea 91M/M + Local 33M/M) + (Korea) Advanced Technician (Korea 91M/M + Local 33M/M)
- (Korea) Intermediate Technician (Korea 92M/M) + (Korea) Beginner Technician (Korea 18M/M)
- (Sri Lanka) Specialized Technician (Local 232M/M) + (Sri Lanka) Advanced Technician (Local 232M/M)

– For the development of land information service system (LISS), Korean developers and local developers collaborate jointly.

- (Korea) Specialized Technician (Korea 10M/M + Local 3M/M) + (Korea) Advanced Technician (Korea 10M/M + Local 3M/M)
- (Korea) Intermediate Technician (Korea 10M/M) + (Korea) Beginner Technician (Korea 2M/M)
- (Sri Lanka) Specialized Technician (Local 37M/M) + (Sri Lanka) Advanced Technician (Local 37M/M)

– For the Integrated test and pilot operation, Korean developers and local developers collaborate jointly.

- (Korea) Advanced Technician (Korea 12M/M + Local 24M/M) + (Korea) Intermediate Technician (Korea 12M/M + Local 24M/M) + (Korea) Beginner Technician (Korea 6M/M + Local 6M/M)
- (Sri Lanka) Specialized Technician (local 60M/M) + (Sri Lanka) Advanced Technician (local 60M/M)

❍ Construction for Data Center and Infrastructure requires a variety of technicians, includi ng networks, information systems, electricity, machinery, architecture, and etc.

– Detailed design of the data center and purchase and production of related equipment: 4 persons

- Network field Specialized Technician 1 person (Korea 2.25month + local 1.5month)
- Information System field Specialized Technician 1 person (Korea 1month + local 1.5month)
- Electricity field Specialized Technician 1 person (Korea 0.5month + local 0.5month)
- Architecture field Specialized Technician 1 person (Korea 0.5month + local 0.5month)

– Establishment of main and backup data centers and improvement of computer environment of regional survey office: 6 persons

- Network and Information System field Specialized Technician 1 person (local 2month)
- Network and Information System Advanced Technician 3 persons (local 2 인/3month + 1 person/2month)
- Electricity field Specialized Technician 1 person (local 2.25month)
- Mechanical field Specialized Technician 1 person (local 2.25month)
- Architecture field Specialized Technician 1 person (local 1.75month)

– Data Center Function and Integration Test: 4 persons

- Network and Information System field Specialized Technician 2 persons (local 4month)
- Network and Information System field Advanced Technician 2 persons (local 4month)

– Stabilization of data center function and pilot operation of remote support: 2 technicians in the field of network and information system (Korea 0.1 month + local 2 month)

❍ Training and capacity building require specialized technicians for network, development, sur veying and advanced technicians are needed for civil construction and machinery to improv e infrastructure.

– Invited training to Korea is conducted twice by 0.5 months of advanced (1 person), intermediate (2) and beginner (2) technicians.

– Local Education Training: 9 persons

- Network and Information System field Specialized Technician 1 person (local 2months)
- Network and Information System field Advanced Technician 1 person (local 2 months)

- Development/Software field Technician 1 person (local 2 months)
- Development/Software field Specialized Technician 3 persons (local 2 months)
- Survey field Technician 1 person (local 2 months)
- Survey field Specialized Technician 2 persons (local 2 months)

– Improving Education Environment : 3 persons

- Civil Construction field Specialized Technician 1 person (local 1month)
- Mechanical field Specialized Technician 1 person(local 2 weeks)
- Mechanical field Advanced Tehcnician1 person(local 1week)

❍ Consulting services require involvement of a large number of Korean technicians, high-quality local personnel in surveying, GIS and data centers.

– RFP; Request for Proposal: 19 persons

- Project General Control (Korea) Specialized Technician 1 person (Korea 3 months + Local 4 months)
- Project General Control (Korea) Specialized Technician 1 person (Korea 2 months + Local 4 months)
- Computerization of CORS and drawings (Korea) Specialized Technician 1 person (Korea 1 month + local 3 months)
- UAV survey (Korea) Specialized Technician 1 person (Korea 1 month + local 3 months)
- Spatial DB Establishment (Korea) Specialized Technician 1 person (Korea 1 month + local 3 months)
- Survey field (Sri Lanka) Specialized Technician 1 person (local 3 months)
- GIS System Development (Korea) Specialized Technician 1 person (Korea 2 months + local 3 months)
- GIS System Development (Korea) Advanced Technician 1 person (Korea 2 months + local 3 months)
- Spatial Information Processing (Korea) Specialized Technician 1 person (Korea 2 months + local 3 months)
- Spatial Information Processing (Korea) Advanced Technician 1 person (local 3 months)
- GIS System Development (Sri Lanka) Specialized Technician 1 person (local 4 months)
- Network and Information System field (Korea) Specialized Technician 1 person (Korea 2.5 months + local 3 months)
- Network and Information System field (Korea) Advanced Technician 1 person (Korea 2 months + local 3 months)
- Information Security field (Korea) Advanced Technician 1 person (Korea 1.5 months + local 2.5 months)
- Construction Equipment field (Korea) Specialized Technician 1 person (Korea 2 months + local 1.5 months)
- Data Center field (Sri Lanka) Specialized Technician 1 person (local 4 months)
- GIS System Development field (Korea) Advanced Technician 1 person (local 4 months)
- Survey field (Korea) Advanced Technician 1 person (local 4 months)

– Select a business operator and support contract: 11 persons

- Project General Control (Korea) Specialized Technician 1 person (Korea 4 months + local 1 month)
- Project General Control (Korea) Specialized Technician 1 person (Korea 3 months + local 1 month)
- Computerization of CORS and drawings (Korea) Specialized Technician 1 person (Korea 1.5months + local 1month)
- UAV Survey (Korea) Specialized Technician 1 person (Korea 1.5months + local 1month)
- Spatial DB Establishment (Korea) Specialized Technician 1 person (Korea 1.5months + local 1month)
- GIS System Development (Korea) Specialized Technician 1 person (Korea 1.5months + local 1.5months)
- GIS System Development (Korea) Advanced Technician 1 person (Korea 1.5months + local 1.5months)
- Network and Information System field (Korea) Specialized Technician 1 person (Korea 1.5month + local 1.5month)
- Construction Equipment field (Korea) Specialized Technician 1 person (Korea 0.5month + local 0.5month)
- GIS System development (Korea) Advanced Technician 1 person (Korea 0.2month + local 1.3month)
- Survey field (Korea) Advanced Technician 1 person (Korea 0.2month + local 1.3months)

– Supervision of the main project: 17 persons

- Project General Control (Korea) Specialized Technician 1 person (Korea 12months + local 7months)
- Project General Control (Korea) Specialized Technician 1 person (Korea 12months + local 7months)
- Computerization of CORS and drawings (Korea) Specialized Technician 1 person (local 5months)
- UAV Survey (Korea) Specialized Technician 1 person (local 4month)
- Spatial DB Establishment (Korea) Specialized Technician 1 person (local 4months)
- Survey field (Sri Lanka) Specialized Technician 1 person (local 6months)
- GIS System Development (Korea) Specialized Technician 1 person (local 10months)
- GIS System Development (Korea) Advanced Technician 1 person (local 8months)
- Spatial Information Processing (Korea) Specialized Technician 1 person (local 4months)
- Spatial Information Processing (Korea) Advanced Technician 1 person (local 4months)
- GIS System Development (Sri Lanka) Specialized Technician 1 person (local 6months)
- Network and Information System (Korea) Specialized Technician 1 person (Korea 6months + local 6months)
- Network and Information System (Korea) Advanced Technician 1 person (Korea 6months + local 6months)
- Information Security field (Korea) Advanced Technician 1 person (Korea 3months + local 2.5months)
- Construction Equipment field (Korea) Specialized Technician 1 person (Korea 2 months + local 9 months)
- Data Center field (Sri Lanka) Specialized Technician 1 person (local 24 months)

  - GIS System Development field (Korea) Advanced Technician 1 person (Korea 7months + local 5months)

❍ Operation and maintenance will continue for two years after the completion of the project.

– Intensive support for operational stability: 10 persons
  - Computerization of CORS and drawings (Korea) Specialized Technician 1 person (Local 3 months)
  - UAV Surveying (Korea) Specialized Technician 1 person (Local 6 months)
  - Spatial DB Establishment (Korea) Specialized Technician 1 person (Local 3 months)
  - Survey field (Sri Lanka) Specialized Technician 1 person (Local 6 months)
  - GIS System Development (Korea) Specialized Technician 1 person (Local 6 months)
  - GIS System Development (Korea) Advanced Technician 2 person (Local 6 months)
  - GIS System Development (Sri Lanka) Specialized Technician 1 person (local 24month)
  - Network and Hardware field (Korea) Specialized Technician 1 person (Local 6 months)
  - Information Security field (Korea) Specialized Technician 1 person (Local 6 months)

– Operational Stabilization General Support: 7 persons
  - UAV Surveying (Korea) Specialized Technician 1 person (Local 6 months)
  - Spatial DB Establishment (Korea) Specialized Technician 1 person (Local 6 months)
  - GIS System Development (Korea) Specialized Technician 1 person (Local 3 months)
  - GIS System Development (Korea) Advanced Technician 1 person (Local 3 months)
  - Network and Hardware field (Korea) Specialized Technician 1 person (Local 3 months)
  - Information Security field (Korea) Specialized Technician 1 person (Local 3 months)

– Capacity building and supplementary training:
  - GNSS CORS (Korea) Advanced Technician 1 person (Local 2 months)
  - UAV Surveying (Korea) Advanced Technician 1 person (Local 2 months)
  - DB/engine/server/integration (Korea) Advanced Technician 1 person (Local 2 months)
  - Advanced program/web service 스 (Korea) Advanced Technician 1 person (Local 2 months)
  - Network and Hardware field (Korea) Advanced Technician 1 person (Local 2 months)
  - Information Security Area (Korea) Advanced Technician 1 person (Local 2 months)

– Operational support and remote support
  - System Development (Korea) One advanced technician (Local 7.5 months)
  - Network and hardware field (Korea) Specialized Technician 1 person (Korea 2.5 months + Local 2 months)
  - Information security field (Korea) Specialized Technician 1 person (Korea 3.5 months + Local 1 month)

Ⅵ. The Project Implementation Organization and the Project Execution System

1. Project Implementation Organization

1.1. Project Implementation Organization and Organizational System

1.1.1. Organizational System of Survey Department of Sri Lanka

❍ Founded in August 1880, the Survey Department of Sri Lanka is Sri Lanka's oldest government organization for more than 200 years, working on surveying, mapping, GPS and telemetry. According to the 2018 Annals, the organization is under the detailed organizational structure of the Survey Department of Sri Lanka, including the Survey Department of Sri Lanka as a surveyor manager:

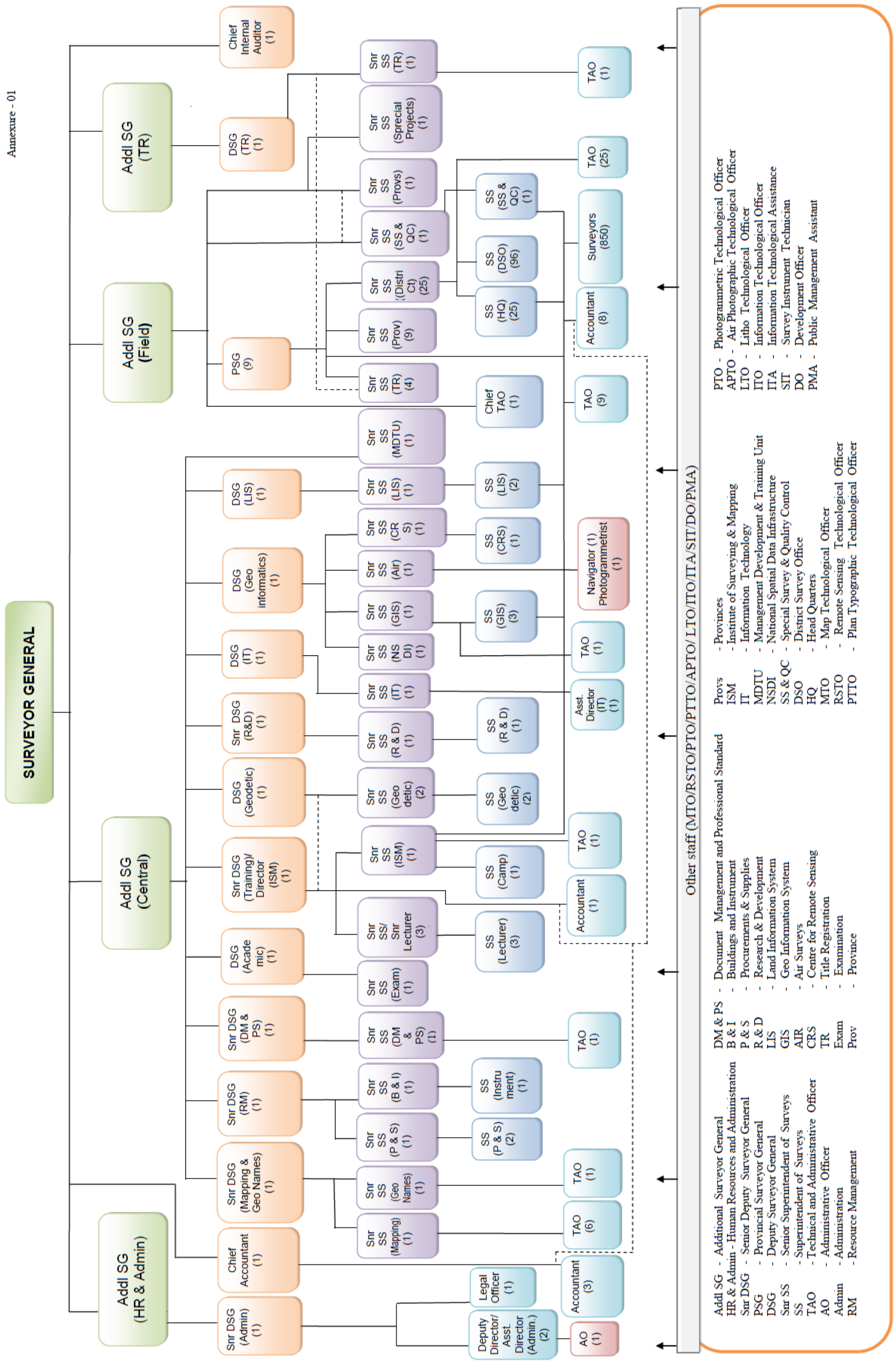
- Additional Surveyor General in charge of labor force and administration
- Additional Surveyor General in charge of the spatial information
- Additional Surveyor General in charge of District Survey Office management
- Additional Surveyor General in charge of land ownership registration

[Table Ⅵ-1] Detailed Labor Force Composition Status of Survey Department of Sri Lanka

Serial No.	Approved Designation	Approved Cadre	Number in previous year	Retirement	Transfers		Left the post	Dead	Left the post to secure &ther posts	Recruitments	Promotions	Staff in year 2018
					Out	In						
1	SurveyorGeneral	01	01									01
2	Addl.SurveyorGeneral (SLSS)	03	03									03
3	Addl.SurveyorGeneral (SLAS)	01	01		01	01						01
4	SeniorDeputySurveyorGeneral	06	06	01							01	06
5	DeputySurveyorGeneral/Provincial SurveyorGeneral	15	15	01							01	15
6	Snr.Supdt.ofSurveys	60	57								02	59
7	Supdt.ofSurveys	139	97	07							04	86
8	Asst.Supdt.ofSurveys/Surveyors ApprenticeSurveyors	850	748	02	05	01	01			49		790
9	ChiefTechnicalandAdministrative Officer	01	0									0

10	TechnicalandAdministrativeOfficer	45	23	05						12		30
11	Snr.MapTechnological Officer(SpecialGrade)	56	40	03					12			25
12	MapTechnologicalOfficer-I,II,III,TrainingGrade	57 4	36 6	10					09			34 7
13	Navigator	01	01									01
14	Photogrammetrist	01	0									0
15	Snr.PhotogrammetricTechnological Officer	04	02									02
16	PhotogrammetricTechnological Officer–I,II,III,TrainingGrade	26	20	03								17
17	Snr.RemoteSensingTechnological Officer	01	0							01		01
18	RemoteSensingTechnological Officer–I,II,III,TrainingGrade	13	10						01			09
19	Snr.AirPhotographicTechnological Officer	01	01									01
20	AirPhotographicTechnological Officer–I,II,III,TrainingGrade	06	05									05
21	Snr.LithoTechnologicalOfficer	03	01									01
22	LithoTechnologicalOfficer–I,II,III,TrainingGrade	15	09									09
23	Snr.PlanTypographicTechnological Officer	01	0									0
24	PlanTypographicTechnological Officer–I,II,III,TrainingGrade	07	03									03
25	TransportOfficer	01	0									0
26	InformationTechnologyAssistant	01	01									01
27	ProgrammerIII	01	0									0
28	DataEntryOperator	01	01									01
29	LegalOfficer	01	01									01
30	LegalAssistant	02	0									0
31	BuildingSupervisor	01	0									0
32	SurveyInstrumentTechnician –SelectionGrade	02	02	01								01
33	SurveyInstrumentTechnician–I,II,III	15	04									04
34	Carpenter-I,II,III	09	03									03
35	Welder	01	01	01								0
36	ToolLabourer	04	04						02			02
37	LorryCleaner	07	06						01			05
38	MapMounter&BookBinder	04	03									03
39	PlanRepairer	07	02							02		04
40	A/CTechnician	01	01									01
41	Mason	01	0									0
42	CircuitBungalowKeeper	05	04									04
43	DarkRoomAssistant	04	03									03
44	PhotocopyMachineOperator	01	01									01

45	DepartmentalLaborer	170	157	08			01		08			140
46	MotorMechanic	02	01						01			0
47	SystemOperator	01	01	01								0
48	DeputyDirector(Administration)/ AssistantDirector(Administration)SLA SII/III											
49	ChiefAccountantSLASI	01	01		01	01						01
50	AccountantSLASII/III	12	10		02	01						9
51	InternalAuditorSLASI	01	01									01
52	Translator	04	01									01
53	AssistantTranslator	01	0									0
54	AdministrativeOfficer	01	0									0
55	P.M.A.S.I,II,III	488	393	14	122	79	05		14	122	03	439
56	DevelopmentOfficer	166	125		06	07	01					125
57	Asst.Director(InformationTechnology andCommunication)	01	01									01
58	InformationandCommunicationOfficer	08	07		01							06
59	InformationandCommunicationTechnologicalAssistant	22	17		03	03						17
60	CombinedServicesDriversServiceSp./I,II,III	319	263	05	27	24	07	01	01	47	04	293
61	OfficeEmployees‟ServiceI,II,III	207	136	02	02	04			09	56	02	183
62	SurveyFieldAssistantgradeI,II,III	4154	3412	177			16	03	12	256	122	3460
63	SystemOperator	02	0									0



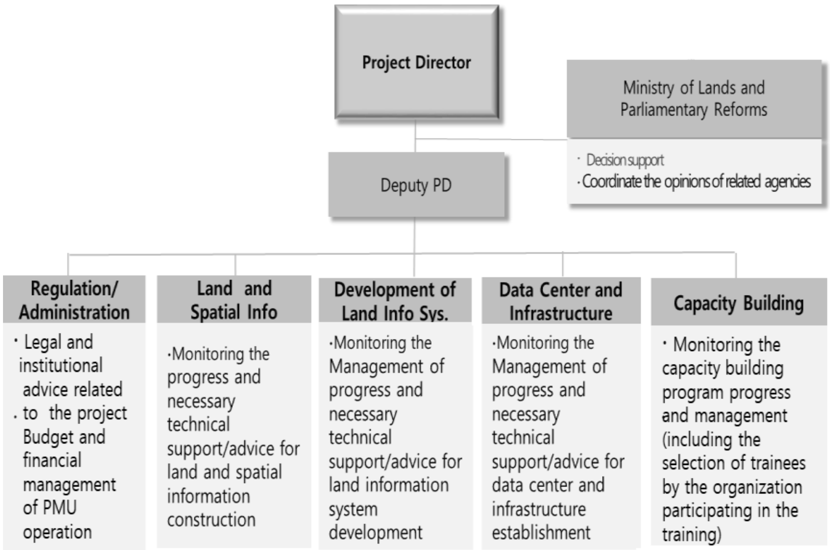
[Figure Ⅵ-1] SDSL Organizational Chart

2. PMU(Project Management Unit) Organizational Configuration (Plan)

- To ensure smooth execution of this project, the Project Management Unit (PMU) is formed within the Survey Department of Sri Lanka based on the existing TFT. The organization c onsists of the Project Executive Manager, the Project Manager, and the Project Manager Ge neral PM (Active/Administration, Training/Capacity Enhancement, Data Acquisition/ Infrastr ucture, IT&System, and Intelligent Quantity).

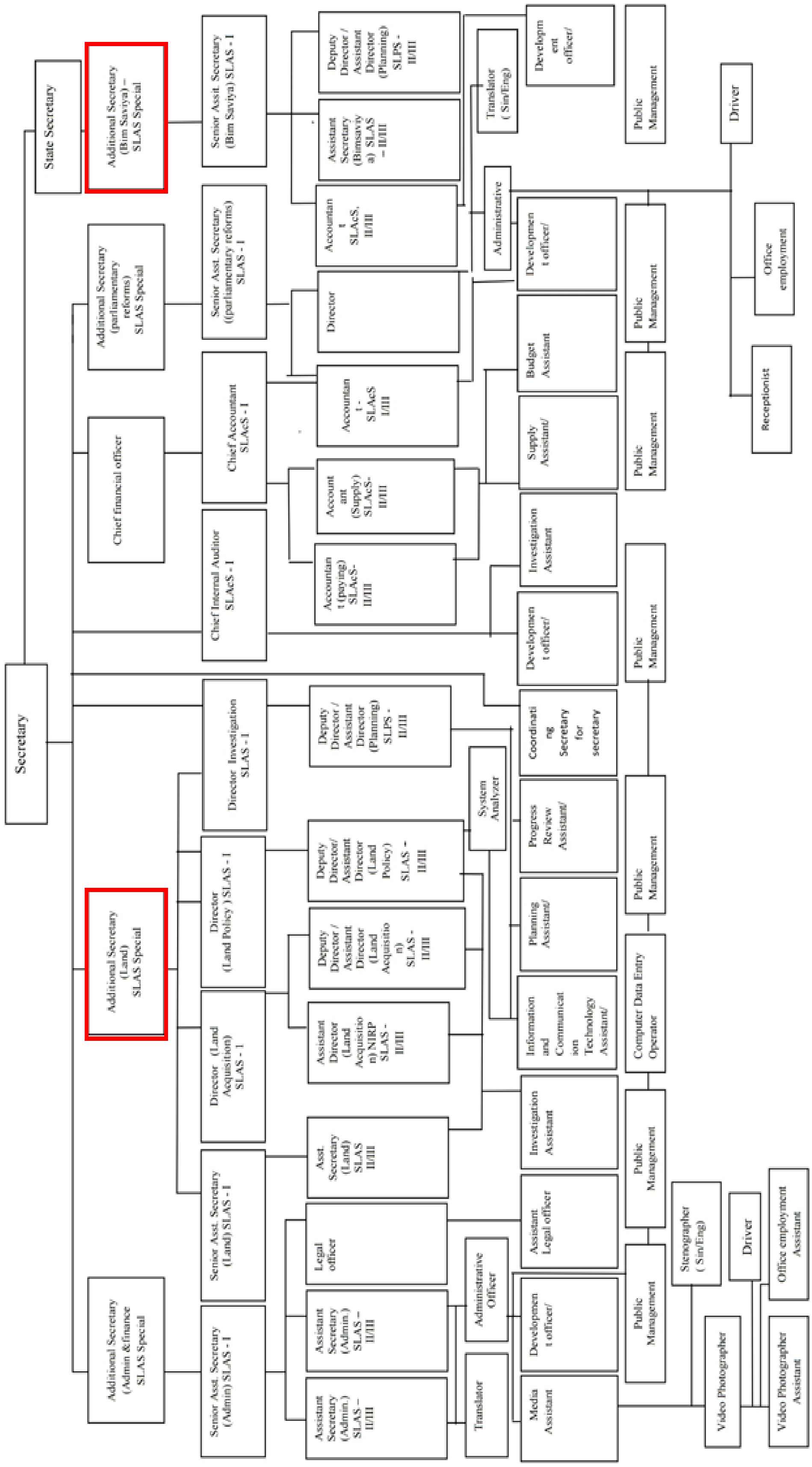
- Survey Department of Sri Lanka is a member of the upper body, the Ministry of Lands and Parliamentary Reforms, and the main competent supervisory department is the Land and Bi m Saviya Division. In charge of supporting major decision-making and coordinating opinion s with related agencies by including the Ministry of Lands and Parliamentary Reforms in th e PMU organization.

- The major tasks of PMU are as the following: .
  - Construction of land and spatial information
  - Land information system development
  - Construction of LISS data center and management infrastructure
  - Capacity Building



[Figure Ⅵ-2] Project Management Unit Structure (Plan)

Organization Chart of the Ministry of Lands and Parliamentary Reforms



[Figure Ⅵ-3] Ministry of Lands and Parliamentary Reforms Organizational Chart

3. Project Management Unit System

3.1. Preparations for Project Management Unit

3.1.1. Project Management Unit Personnel Structure (Plan)

❍ The project implementation organization carries out the following essential major activities to establish a platform capable of a land information integration system and data sharing system:

- Development of cadastral information/spatial information (field survey and drawing computerization)
- Construction of data center and management infrastructure
- Education training
- Management and maintenance
- Constructing land information and spatial information service system
- Constructing land administration system

[Table Ⅵ-2] Role of Project Management Unit (Plan)

Classification	Criteria	Role
Supreme Decision-Making Authority	Total Management of Project	Decision making, policy coordination, and dispute settlement concerning the whole business as the head of the cadastral Property Office should be taken for granted.
Overall Project PM	Overall Project Management	Report and progress management of the overall work at the instruction of the supreme decision maker.
Deputy PD of Overall Project Management	Overall Practical Affairs Management	As the practical affairs manager, work order and progress is checked through real-time communication with the working group.
Land and Development Division	Foreign Cooperation	Coordinating opinions with other ministries by managing and supervising the main project as an upper body of the survey office.
Practical Personnel	Legislation/Administration	The role of administrative support (law support, etc.) in charge of administrative and financial affairs of the project.
	Education	Development/implementation of education to improve the enhancing of the competitive advantage of the participating personnel of the project.
	Data Acquisition/Infrastructure	Responsible for processing/creating data such as video and satellites and for building various infrastructures (data centers, etc.)

Classification	Criteria	Role
	Configuration	
	System	Planning system development plan, business analysis for overall technical support for system development, design, development, verification, system operation
	Direct Survey	Direct provincial survey implementation plan and implementation in areas where data cannot be obtained through satellite and aero survey

3.1.2.Role of Project Management Unit

❍ The Project Management Unit consists of four business areas and each has the following role s:

– Law: Cooperation with existing land laws and enforcement procedures, issues to be overcome during implementation of the proposed project and other administrative support.

– Capability Enhancement: Build capabilities for departments needing capability, enhance infrastructure, identify interactive video conferencing/on-line education facilities available at educational institutions (e.g., SLIDA) and prepare education curricula if necessary.

– Data Acquisition: Gathering information on existing survey plans and digitalization of data. Improve spatial data acquisition and recording mechanisms (large and small) and computerize work currently used in SDSL

– IT & System: Onsite office and data storage systems, data communication centers or other system structures/architectures, etc.

3.2.Project Implementation Cooperation System

3.2.1.Cooperating Organization

❍ Ministry of Digital Infrastructure and Information Technology

– Responsible for monitoring and evaluation of communication related policies, projects, telecommunications and digital infrastructure, and is responsible for providing various telecommunication facilities for the introduction of the latest technology.

– -Support for optimal solutions to promote productivity and efficiency in the provision of public services.

– Developing strategies for the development of information and communication technologies

❍ Ministry of Lands and Parliamentary Reforms

– The main goal is to contribute to sustainable development through efficient land management and optimal utilization, while strengthening land ownership, while ensuring optimal effective and efficient management of national resources through policy planning, execution and coordination

– Major Task

1) Renewing and implementing national territory policy

2) Preserving the environment for future generations

3) Ensuring the protection of the state

4) Implementing land-use policies

5) Measures for the minimum utilization and prevention of decline of state land

6) Manage and develop national land and distribute land

7) Allocation of land for development projects and other essential purposes

8) Register all land and guarantee ownership

❍ Registrar General’s Department

– Responsible for the preservation and the issuance of copies and various related support of documents, such as the registration of legal documents containing real estate and the registration of marriage, birth and death.

– Land registration procedures are carried out per district and 45 land registrations have been set up in Sri Lanka for this purpose.

– Major Task

1) Performing major domestic registrations such as marriage, birth and death

2) Registering legal documents on real estate and non-property moving

3) Preservation of records related to such registration and issuance of certified copies of such records

❍ Land Commissioner General’s Department

– The government controls and manages state land, distributes the land to individuals and institutions for various purposes, and the individual departments consist of the land department, the development department, the legal department, the administration and the accounting finance ministry.

– Major Task

1) Long-term lease and transfer for residential/commercial/agricultural purposes

2) Dissemination of national land for public purposes

3) Land distribution to long-term rental or special economic development projects, etc.

4) Interregional irrigation and land development project management

5) Resettlement plan and execution according to the Land Development Ordinance

3.3. The Process of Promoting and Approving the ODA Project in Recipient Country[36]

- Sri Lanka is one of the most important EDCF countries, with emphasis on roads, water resources, education, and renewable energy, etc. According to the mid-to-long-term national development plan (Poverty Reduction Plan and the 1,500 days Economic Development Plan), the goal of ODA project is sustainable growth, and the criteria for selecting projects are selected by considering Sri Lanka's poverty eradication, national economic development plan, and budget/finance.
- For the recipient country system procedure, the following organizations are cooperating:

1) Ministry of National Policies and Economic Affairs of Sri Lanka needs to approve for assistance while carrying out aid procedures with donor countries and agencies in general.

2) Department of National Planning within the Ministry of National Policies and Economic Affairs needs to review to prioritize aid.

3) Allocation of organization aid funds by the Department of External Resources on the basis of review by the Ministry of National Policies and Economic Affairs and the Department of National Planning.

4) Post-management in the Department of Project Management and Monitoring for efficient post-management of budgets.

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Ⅶ. Project Cost Estimation

1.Estimated Project Costs and Financing Plan

1.1.Estimated Project Costs

[Table Ⅶ-1] Estimated Project Costs

(Unit: 1,000 USD)

Item	EDCF				GoSL	Total
	Foreign Currency		Local Currency	EDCF Total		
	Korea	3rd Countries				
1. Land and Spatial Information D	5,267	5,192	15,804	26,263		26,263
2. Land Information System Development	7,272	81	1,187	8,540		8,540
3. Data Center and Infrastructure	2,011	4,087	106	6,204	166	6,370
4. Capacity Building	897	274	469	1,640	307	1,947
5. Consulting Service	3,864		506	4,370		4,370
6. Operation & Maintenance Support	1,405	78	204	1,687		1,687
7. PMU(Project Management Unit)					680	680
Direct Cost	20,716	9,712	18,276	48,704	1,153	49,857
8. Taxes and Duties					4,285	4,285
9. Contingency	1,683	1,292	3,159	6,134		6,134
10.Service Charges EDCF loan						
Total Budget	22,453	11,004	21,435	54,892	5,438	60,330

* All taxes, duties, and levies imposed on goods and services in the democratic socialist republic of Sri Lanka provided by the Suppliers will be exempted by the Government of Sri Lanka.

1.2.Financing Plan

- ❍ Based on the results of the feasibility study, the total project costs for this project amount t o USD 60,330,000. USD 54,892,000, which is 91% of the total project costs, will be raised through an EDCF loan, while the government of Sri Lanka or SDSL will bear 9% of the t otal project costs, which works out to be USD 5,438,000.

[Table Ⅶ-2] Financing Plan

(Unit: 1,000 USD)

Item	EDCF				GoSL	Total
	Foreign Currency		Local Currency	EDCF Total		
	Korea	3rd Countries				
Project Cost	22,453	11,004	21,435	54,892	5,438	60,330
EDCF Ratio (%)	40.90	20.05	39.05	100.00		
Ratio (%)	37.217	18.240	35.530	90.986	9.014	100.000

1.3.Annual Budget Plan

[Table Ⅶ-3] Annual Project Costs

(Unit: 1,000 USD)

Item	Y0*	Y1	Y2	Y3	Beyond Y4	Total
1. Land and Spatial Information DB		11,462	11,684	3,117		26,263
2. Land Information System Development		3,454	3,436	1,650		8,540
3. Establishment of Data Center and Infrastructure		2,481	2,616	1,273		6,370
4. Capacity Building		314	1,503	130		1,947
5. Consulting Service	1,756	872	871	871		4,370
6. Operation & Maintenance Support					1,687	1,687
7. PMU(Project Management Unit)	170	170	170	170		680
Direct Cost	1,926	18,753	20,280	7,211	1,687	49,857

2.Estimated Project Costs in Detail

2.1.Project Costs for Land and Spatial Information DB

2.1.1.Project Cost Calculation Standards

[Table Ⅶ-4] Standards for Calculating Cost of Land and Spatial Information DB

<table>
<tr><th>Category</th><th>Item</th><th>Calculation basis and standard</th><th>Description</th></tr>
<tr><td rowspan="2">Survey and database setup costs</td><td>Itemized unit cost calculation method</td><td>Calculation of the unit cost of each unit process (calculation based on manpower input and days of work per unit process)</td><td>Application of the 2018 standard of estimate for construction</td></tr>
<tr><td colspan="3">
<table>
<tr><th>Category</th><th>Unit process</th></tr>
<tr><td rowspan="6">Computerization of Old Survey Plans</td><td>Inspection of scanned data</td></tr>
<tr><td>Rescanning of poor-quality scanned data</td></tr>
<tr><td>Reference point extractions, ground coordinate input and geo-referencing</td></tr>
<tr><td>Geometry check for geo-referencing and adjacency adjustment</td></tr>
<tr><td>Digitizing by parcel</td></tr>
<tr><td>Digitizing inspection and spatial data generation</td></tr>
<tr><td rowspan="8">Construction of Spatial DB for 24 MCs</td><td>UAV survey for the 24MCs</td></tr>
<tr><td>Digitizing parcel objects for the 24MCs</td></tr>
<tr><td>Digitizing building objects for the 24MCs</td></tr>
<tr><td>Digitizing street objects for the 24MCs</td></tr>
<tr><td>Field check and complementary survey of the 24MCs</td></tr>
<tr><td>Create and editing spatial data for the 24MCs</td></tr>
<tr><td>Enter and investigate attribute data for the 24MCs</td></tr>
<tr><td>Spatial DB inspection and structured editing for the 24MCs</td></tr>
<tr><td rowspan="4">Additional installations of the CORS Network
(32 locations)</td><td>Check the locations for the additional installations</td></tr>
<tr><td>Equipment inspection and delivery</td></tr>
<tr><td>On-site checking and inspection of installation</td></tr>
<tr><td>Test operation and inspection (Network Adjustment)</td></tr>
<tr><td rowspan="3">50cm satellite orthoimage production</td><td>GCP selection and GCP survey</td></tr>
<tr><td>Satellite image ortho rectification</td></tr>
<tr><td>Image mosaic and color correction</td></tr>
</table>
</td></tr>
</table>

Category	Item	Calculation basis and standard	Description
	Tiling of orthoimages		
Labor costs	Korean experts	1) Direct labor costs: Apply the 2019 unit wages for surveyors 2) Indirect labor costs: Comply with the guidelines of the Korea Export-Import Bank 3) Overhead expenses: Comply with the guidelines of the Korea Export-Import Bank	Korea Association of Spatial Information, Survey & Mapping
	Local experts	Data obtained on the labor costs incurring from database setup and in relation to the surveyors of local firms provided during the project period	
Direct cost	Calculation as local business trip expenses according to the number of workers and total working days for each process (international airfares, visa fees, expenses during stay, vehicle rental fees, interpreter fees)		
Establishment of a workplace	Surveying results management and database setup workplace: One integrated office (excl. network, security equipment and software)		
Transportation	Shipping is the first choice / But some transported via air		

1) Computerization of Old Survey Plans

① Inspection of scanned data

Total number of sheets: 82,303

Workload/person/day: 200 sheets (standard: local advanced technician – 8 hours of work)

Required time with 1 worker: 400 days

Required time with 10 workers: 40 days

② Rescanning of poor-quality scanned data

Total number of sheets: 8,230 (10% of total number of sheets, 82,303)

Workload/person/day: 40 sheets (standard: local intermediate technician - 8 hours of work)

Required time with 1 worker: 193 days

Required time with 10 workers: 19 days

③ Reference point extractions, ground coordinate input and geo-referencing

Total number of sheets: 82,303

Workload/person/day: 8 sheets (standard: local intermediate technician – 8 hours of work)

Required time with 1 worker: 10,317 days

Required time with 100 workers: 103 days

④ Geometry check for geo-referencing and adjacency adjustment

Total number of sheets: 82,303

Workload/person/day: 200sheets(standard: Korean intermediate technician – 8 hours of work)

Required time with 1 worker: 402 days

Required time with 10 workers: 40 days

⑤ Parcel digitizing

Total quantity: 3,275,623 lots

Workload/person/day: 50 lots (standard: local intermediate technician – 8 hours of work)
Required time with 1 worker: 65,720 days
Required time with 200 workers: 329 days

⑥ Digitizing inspection
Total quantity: 3,275,623 lots
Workload/person/day: 300 lots (standard: local intermediate technician – 8 hours of work)
Required time with 1 worker: 10,933 days
Required time with 100 workers: 109 days

⑦ Spatial data generation (parcels)
Total quantity: 3,275,623 lots
Workload/person/day: 3,000 lots (standard: Korean intermediate technician – 8 hours of work)
Required time with 1 worker: 1,110 days
Required time with 10 workers: 111 days

2) Construction of spatial DB for the 24MCs

① AV survey (based on 10㎢)
- Work plan: 2 advanced technicians (Korean), 5 days of work
- Ground control point selection and survey:
2 advanced technicians (Korean), 5 days of work
4 advanced technicians (local), 5 days of work
2 intermediate technician(local), 5 days of work
- UAV flight and data acquisition (included supplementary flight):
2 advanced technicians (Korean), 5 days of work
2 advanced technicians (local), 5 days of work
2 intermediate technicians (local), 5 days of work
- Data processing:
2 advanced technicians (Korean), 10 days of work
2 advanced technicians (local), 10 days of work
- Production of final results: 2 advanced technicians (Korean), 3 days of work
- Total area: 708.08㎢

② Digitizing parcel objects
Total number of parcels: 2,092,539 parcels (area: 708.02㎢)
Workload/person/day: 100 parcels (standard: local intermediate technician)
Required time with 1 worker: 20,916 days
Required time with 200 workers: 105 days

③ Digitizing of building objects
Total number of buildings: 973,887 buildings
Workload/person/day: 100 buildings (standard: local intermediate technician)
Required time with 1 worker: 9,727 days
Required time with 200 workers: 49 days

④ Digitizing of road objects

Total road length: 8,843㎞

Workload/person/day: 5㎞ of road (standard: local intermediate technician)

Required time with 1 worker: 1,757 days

Required time with 200 workers: 9 days

⑤ Inspection of digitizing results

Total number of parcels: 2,092,539 parcels (area: 708.02㎢) - in the case of buildings and roads, check overlay with parcels

Workload/person/day: 800 parcels (standard: local intermediate technician)

Required time with 1 worker: 2,607 days

Required time with 20 workers: 130 days

⑥ On-Site complementary survey

Total quantity for field repletion survey: 418,499 parcels (20% of total parcels) - reflecting the results of the LX pilot project

Workload/survey team/day: 30 parcels (buildings and streets appropriated separately)

Composition of a survey team: 1 local advanced technician and 2 local intermediate technicians

Required time with 1 survey team: 13,938 days (included parcels, buildings, and streets)

Required time with 199 surveying teams: 70 days

⑦ Processing/editing of spatial data (parcels, buildings and streets) for field complemntary survey

Total number of parcels: 2,092,539 parcels (area: 708.02㎢) - buildings and streets done in parallel with parcels

Workload/person/day: 150 parcels (standard: local intermediate technician)

Required time with 1 worker: 13,938 days

Required time with 200 workers: 70 days

⑧ Examination/input of attribute data (parcels, buildings and streets)

Total number of parcels: 2,092,539 parcels (area: 708.02㎢) - buildings and streets done in parallel with parcels

Workload/person/day: 200 parcels (standard: local intermediate technician)

Required time with 1 worker: 10,479 days

Required time with 200 workers: 52 days

⑨ Inspection of spatial/attribute data (parcels, buildings and streets)

Total number of parcels: 2,092,539 parcels (area: 708.02㎢) - buildings and streets done in parallel with parcels

Workload/person/day: 800 parcels (standard: local advanced technician)

Required time with 1 worker: 2,613 days

Required time with 30 workers: 87 days

⑩ Spatial database structured editing (parcels, buildings and streets)

Total number of parcels: 2,092,539 parcels (area: 708.02㎢) - buildings and streets done in parallel with parcels

Workload/person/day: 4,000 parcels (standard: Korean intermediate technician)

Required time with 1 worker: 527 days

Required time with 10 workers: 53 days

3) Additional installations of the CORS Network (32 locations)

① Check the locations for additional installations

Total number of locations checked: 32 locations

Composition of each group organized for the field check: 1 Korean special-class technician and 1 Korean advanced technician

Workload/group/day: Check 1.5 location

Time required for examination: 22 days

② Equipment inspection and delivery

Composition of each group organized for equipment inspection: 1 Korean special-class technician and 1 Korean advanced technician

Time required for local equipment inspection and delivery: 15 days

③ Test operation and inspection

Composition of each group organized for test operation and inspection: 1 Korean special-class technician and 1 Korean advanced technician

Time required for test operation and inspection: 30 days (included Network Adjustment)

4) 50cm satellite orthoimage production

① Ground control point selection and surveying

50cm satellite images: 95 scenes

Selection of 6 GPS locations per scene

Total GCP surveying quantity: 570 stations

Composition of one group of the GCP surveying team: 2 local advanced technicians and 2 local intermediate technicians

Workload/group/day: 3 stations

Required time with 1 group: 190 days

Required time with 5 groups: 38 days

② Satellite image ortho rectification

2 Korean advanced technicians, 35 days

1 Korean intermediate technician, 35 days

③ Orthoimage production and editing

2 Korean advanced technician, 5 days

1 Korean intermediate technician, 5 days

④ Tiling of orthoimages

1 advanced technician, 30 days

1 intermediate technician, 30 days

2.1.2.Project Cost Estimation

[Table Ⅶ-5] Estimation of Project Costs for Land and Spatial Information DB

(unit : 1,000 USD)

Item	EDCF				GOSL /SDSL	Total
	Foreign Currency Portion		Local Currency Portion	EDCF Total		
	Korea	3rd Countries				
Total	5,267	5,192	15,804	26,263	-	26,263
Computerization of Old Survey Plans	878	-	6,916	7,794	-	7,794
Construction of spatial DB for the 24MCs	2,918	-	8,762	11,680	-	11,680
Additional installations of the CORS Network (32 locations)	105	2,530	19	2,654	-	2,654
50cm satellite orthoimage production	938	1,640	107	2,685	-	2,685
Provision of survey equipment (and materials)	428	1,022	-	1,450	-	1,450

[Table Ⅶ-6] Cost Breakdown for Computerization of Old Survey Plans

(unit : 1,000 USD)

Item	EDCF				GOSL /SDSL	Total
	Foreign Currency Portion		Local Currency Portion	EDCF Total		
	Korea	3rd Countries				
Total	878	0	6,916	7,794	-	7,794
Inspection of scanned data	-	-	22	22	-	22
Rescanning of poor-quality scanned data	-	-	15	15	-	15
Reference point extractions, ground coordinate input and geo-referencing	-	-	802	802	-	802
Geometry check for geo-referencing and adjacency adjustment	151	-	-	151	-	151
Parcel Digitizing	-	-	5,108	5,108	-	5,108
Digitizing inspection and spatial data generation	417	-	850	1,267	-	1,267
Direct cost	310	-	119	429	-	429

[Table Ⅶ-7] Cost Breakdown for Construction of spatial DB for 24MCs

(unit : 1,000 USD)

Item	EDCF				GOSL /SDSL	Total
	Foreign Currency Portion		Local Currency Portion	EDCF Total		
	Korea	3rd Countries				
Total	2,918	0	8,762	11,680	-	11,680
UAV survey	1,705	-	312	2,017	-	2,017
Digitizing parcel objects	-	-	1,626	1,626	-	1,626
Digitizing building objects	-	-	756	756	-	756
Digitizing street objects	-	-	136	136	-	136
Inspection of digitizing results	-	-	149	149	-	149
On-Site complementary survey	-	-	2,940	2,940	-	2,940
Create and editing of spatial data	-	-	797	797	-	797
Investigation and input of attribute data	-	-	814	814	-	814
Special database inspection and structured editing	227	-	149	376	-	376
Direct cost	986	-	1,083	2,029	-	2,029

[Table Ⅶ-8] Cost Breakdown for Additional Installations of the CORS Network (32 Locations)

(unit : 1,000 USD)

Item	EDCF				GOSL /SDSL	Total
	Foreign Currency Portion		Local Currency Portion	EDCF Total		
	Korea	3rd Countries				
Total	105	2,530	19	2,654	-	2,654
CORS equipment and installation	-	2,530	-	2,530	-	2,530
Direct labor costs	69	-	-	69	-	69
Direct cost	36	-	19	55	-	55

[Table Ⅶ-9] Cost Breakdown for 50cm Satellite OrthoImage Production

(unit : 1,000 USD)

Item	EDCF				GOSL /SDSL	Total
	Foreign Currency Portion		Local Currency Portion	EDCF Total		
	Korea	3rd Countries				
Total	938	1,640	107	2,685	-	2,685
KOMPSAT 3, 3A	810	-	-	810	-	810
1m DEM	-	1,640	-	1,640	-	1,640
GCP selection and Survey results verification	25	-	-	25	-	25
GCP Survey	-	-	97	97	-	97
Satellite image ortho rectification and orthoimage production	68	-	-	68	-	68
Tiling of orthoimages	10	-	-	10	-	10
Direct cost	25	-	10	35	-	35

[Table Ⅶ-10] Cost Breakdown for Provision of Survey Equipment (and Materials)

(unit : 1,000 USD)

Item	EDCF				GOSL /SDSL	Total
	Foreign Currency Portion		Local Currency Portion	EDCF Total		
	Korea	3rd Countries				
Total	1,137	1,022	0	1,450	-	1,450
UAV survey equipment	204	-	-	205	-	205
UAV data processing workstation	-	85	-	85	-	85
UAV data processing software	-	55	-	55	-	55
GNSS survey equipment	-	314	-	341	-	341
GNSS survey equipment (Preliminary quantity)	-	41	-	41		41
Total station survey equipment	-	192	-	192	-	192
Total station survey equipment (Preliminary quantity)	-	23	-	23		23
Pen-Computer system	-	64	-	64	-	64
Pen-Computer system (Preliminary quantity)	-	8	-	8		8

Item	EDCF				GOSL /SDSL	Total
	Foreign Currency Portion		Local Currency Portion	EDCF Total		
	Korea	3rd Countries				
PC for database construction	213	-	-	213	-	213
Workstation for database construction and management	-	213	-	213	-	213
Shipping and delivery fee	11	-	-	11	-	11

2.2.Development of LIS

2.2.1.Calculation Standards

[Table Ⅶ-11] Calculation Standards for Establishment of Land Information System

Classification	Item	Calculation basis and standards
Software development costs	Direct labor costs	Calculation of direct labor costs for the manpower assigned to software development Direct labor costs = Man hours by developer class × Monthly unit price for labor by developer class
	Overhead expenses and engineering fees	Calculation of overhead expenses and engineering fees for the manpower assigned to software development -Overhead expenses = Direct labor costs × 110% -Engineering fees = Direct labor costs × 40%
	Total	Software development costs = Labor costs for Korean experts (direct labor costs + overhead expenses + engineering fees) + Labor costs for local experts (direct labor costs)
Unit price for labor costs	Korean experts	Apply the monthly unit price for software technicians in 2018
	Local experts	Apply the monthly unit price for labor in the private ICT industry of Sri Lanka
Direct costs	Common standards	
Development environment setup	Hardware & software	A set of hardware and software with the same conditions set up in Korea and Sri Lanka each (excl. network, security equipment and software)

2.2.2.Project Cost Estimation

[Table Ⅶ-12] LIS Development Costs

(Unit: 1,000 USD)

Item			EDCF				GoSL Portion	Total
			Foreign Currency		Local Currency	EDCF Total		
			Korea	3rd country				
Software development costs	LAS development		5,064		727	5,791		5,791
	LISS development		535		115	650		650
	Integration test and pilot operation		985		188	1,173		1,173
Direct costs	Airfare and living expenses		562		157	719		719
	Development environment setup	Software procurement	126	61		187		187
		Development server procurement		20		20		20
Total			7,272	81	1,187	8,540		8,540

1) Software development cost

❍ Software development costs calculated based on man hours

[Table Ⅶ-13] System Development Labor Costs by Man Hour

(Unit: 1,000 USD)

System	Korean manpower (M/M)				Local manpower (M/M)		Korean labor costs			Korea labor cost total	Local labor costs	Total
	Special class	Advanced	Intermediate	Beginner	Special class	Advanced	Direct labor costs	Overhead expenses	Engineering fees			
1. Land administration system (LAS)	125	125	92	18	232	232	2,022	2,225	806	5,064	727	5,791
1) Land registration system	11.5	11.5	10	1	30	30	191	211	76	478	94	572
2) Land information inquiry system	6	6	6	0.5	18	18	103	113	41	258	56	314
3) Cadastral map management system	7.5	7.5	7	0.5	16	16	126	139	50	316	49	366
4) Field surveying system	27	27	22	2	26	26	442	486	177	1,105	81	1,186

System	Korean manpower (M/M)				Local manpower (M/M)		Korean labor costs			Korea labor cost total	Local labor costs	Total
	Special class	Advanced	Intermediate	Beginner	Special class	Advanced	Direct labor costs	Overhead expenses	Engineering fees			
5) Surveying application information management system	8.25	8.25	2.5	3	13	13	126	138	50	316	40	356
6) Surveying results preparation system	12	12	6	2	21	21	184	203	73	461	66	527
7) Surveying inspection system	8	8	5	2	17	17	130	142	51	324	53	378
8) Surveying document management system	8.75	8.75	7.5	1	15	15	146	160	58	365	47	412
9) Drawing editing system	10	9	7	2	27	27	152	166	61	380	84	464
10) System management	10	10	6.5	1	20	20	157	173	62	394	62	456
11) Channel system	13	13	8.5	2	11	11	201	222	81	504	34	538
2. Land information service system	3	4	4	1	18	18	64	71	26	160	56	217
3. Integration testing and test operation	13	13	10	2	37	37	214	235	85	534	116	650
Total	-	36	36	12	60	60	394	433	157	985	188	1,173

2) Direct Costs

[Table Ⅶ-14] Direct Costs of LIS Development

(Unit: USD)

Direct costs			Quantity	Amount
LAS	Business trip expenses for analysis and design	Airfare (16 people * 1 time)	16 times	24,000
		Daily expenses, meal costs, accommodations (16 people * 28days)	448 days	54,656
		Car rental fees(2 cars * 20 days)	40 days	5,200
		Interpreter fees(2 people * 20 days)	40 days	5,200

Direct costs			Quantity	Amount
		Visa(16 people * 1 time)	16 times	800
	Business trip expenses for design and development of functions	Airfare(10 people * 5 times)	50 times	75,000
		Daily expenses, meal costs, accommodations(10 people * 140 days)	1,400 days	170,800
		Car rental fees(2 cars * 100 days)	300 days	26,000
		Interpreter fees(2 people * 100 days)	300 days	26,000
		Visa(10 people * 5 times)	50 회	2,500
	Business trip expenses for test operation	Airfare(5 people * 2 times)	10 회	15,000
		Daily expenses, meal costs, accommodations (5 people * 168 days)	840 days	102,480
		Car rental fees(2 cars * 120 days)	240 days	31,200
		Interpreter fees(1 person * 120 days)	120 days	15,600
		Visa(5 people * 2 times)	10 times	500
	Business trip expenses for system stabilization	Airfare(4 people * 2 times)	8 times	12,000
		Daily expenses, meal costs, accommodations\ (4 people * 168 days)	672 days	81,984
		Car rental fees(1 car * 120 days)	120 days	15,600
		Interpreter fees(1 person * 120 days)	120 days	15,600
		Visa(4 people * 2 times)	8 times	400
LISS	Business trip expenses for system analysis and design	Airfare(2 people * 1 time)	2 times	3,000
		Daily expenses, meal costs, accommodations (2 people * 14 days)	28 days	3,416
		Car rental fees(1 car * 10 days)	10 days	1,300
		Interpreter fees(1 person * 10 days)	10 days	1,300

Direct costs			Quantity	Amount
		Visa(2 people * 1 time)	2 times	100
	Business trip expenses for development of functions	Airfare(2 people * 2 times)	4 times	6,000
		Daily expenses, meal costs, accommodations (2 people * 56 days)	112 days	13,664
		Car rental fees(1 car * 40 days)	40 days	5,200
		Interpreter fees(1 person * 40 days)	40 days	5,200
		Visa(2 people * 2 times)	4 times	200
Development environment setup	DBMS procurement	Oracle	1 set	61,404
	Security solution procurement	SSO(Single Sign On) S/W	1 set	126,220
	WEB/WASS server procurement	WEB/WAS server procurement (refer to the cost calculation for building the data center and operating infrastructure)	1 set	9,864
	DB server procurement	DB server procurement (refer to the cost calculation for building the data center and operating infrastructure)	1set	10,545
Total direct costs				927,933

2.2.3.Project Costs by Year

[Table Ⅶ-15] Cost Breakdown by Year

(Unit: 1,000 USD)

<table>
<tr><th rowspan="3">Item</th><th colspan="4">EDCF</th><th rowspan="3">GOSL</th><th rowspan="3">Y1</th><th rowspan="3">Y2</th><th rowspan="3">Y3</th><th rowspan="3">Total</th></tr>
<tr><th colspan="2">Foreign Currency Portion</th><th rowspan="2">Local Currency Portion</th><th rowspan="2">EDCF Total</th></tr>
<tr><th>Korea</th><th>3rd Countries</th></tr>
<tr><td>Land administration system (LAS)</td><td>5,064</td><td></td><td>727</td><td>5,791</td><td>-</td><td>3,225</td><td>2,566</td><td>-</td><td>5,791</td></tr>
<tr><td>Land Information Service System</td><td>535</td><td></td><td>115</td><td>650</td><td>-</td><td>-</td><td>650</td><td>-</td><td>650</td></tr>
<tr><td>Integrated testing and pilot operation</td><td>985</td><td></td><td>188</td><td>1,173</td><td>-</td><td>-</td><td>-</td><td>1,173</td><td>1,173</td></tr>
<tr><td>Travel expenses, etc.</td><td>562</td><td></td><td>157</td><td>719</td><td>-</td><td>209</td><td>220</td><td>290</td><td>719</td></tr>
<tr><td>Development environment setup</td><td>126</td><td>81</td><td></td><td>207</td><td>-</td><td>20</td><td>-</td><td>187</td><td>207</td></tr>
<tr><td>Total</td><td>7,272</td><td>81</td><td>1,187</td><td>8,540</td><td></td><td>3,454</td><td>3,436</td><td>1,650</td><td>8,540</td></tr>
</table>

2.3.Data Center and Infrastructure

2.3.1.Calculation Standards

[Table Ⅶ-16] Calculation Standards for Establishment of Data Center and Operating Infrastructure

<table>
<tr><th>Category</th><th>Item</th><th>Calculation Standards</th><th>Description</th></tr>
<tr><td rowspan="2">Establishment of IT infrastructure</td><td rowspan="2">Calculation of capacity</td><td>Based on the [Guide on Calculating Information System Hardware Scale] (Telecommunication Technology Association, TTA)</td><td>Basic data on database servers with simultaneous access and users and basic data on WEB/WAS server</td></tr>
<tr><td colspan="2">
<table>
<tr><th colspan="2" rowspan="2">Category</th><th colspan="2">DB server</th><th colspan="2">WEB/WAS server</th></tr>
<tr><th>Calculated value</th><th>Confirmed value</th><th>Calculated value</th><th>Confirmed value</th></tr>
<tr><td colspan="2">CPU</td><td colspan="2">559,718tpmc</td><td colspan="2">85,217 ops</td></tr>
<tr><td colspan="2">Memory</td><td colspan="2">4,574MB</td><td colspan="2">4,192MB</td></tr>
<tr><td rowspan="2">Disk</td><td>System</td><td colspan="2">12,967MB</td><td colspan="2">12,967MB</td></tr>
<tr><td>Data</td><td colspan="2">55,473MB</td><td colspan="2"></td></tr>
<tr><td>Storage</td><td>Site</td><td colspan="2">Storage type</td><td colspan="2">Expected capacity</td></tr>
</table>
</td></tr>
</table>

Category	Item	Calculation Standards			Description
			Main data center	SAN method	Disk Array #1: 300 TB Disk Array #2: 100 TB VTL: 200 TB
			Backup data center	SAN method	Disk Array #1: 300 TB Disk Array #2: 100 TB VTL: 200 TB
	Purchase	List Price / Vendor Price			Based on quotation
Local computer room	Calculation o capacity	Calculated based on the latest devices			Collection of list of selected equipment and quotations according to specifications
	Purchase	Calculated based on the Internet/quotation			
Installation and integration test	Labor costs	Direct labor costs: Engineering Labor Unit Price Table (2018) Indirect labor costs: KEXIM Guideline			Korea Engineering Consulting Association (KENCA), 2018)
Transportation		Shipping is the first choice / But some transported via air			

2.3.2.Project Cost Estimation

[Table Ⅶ-17] Data Center and Operating Infrastructure Project Cost Estimation

(Unit: USD)

Item	EDCF				GoSL	Total
	Foreign Currency		Local Currency	EDCF Total		
	Korea	3rd Countries				
Total	2,011,000	4,087,000	106,000	6,204,000	-	6,370,000
Main Data Center (SDSL-IT Branch)	821,000	1,380,000	-	2,201,000	-	2,201,000
Backup Data Center (Sri Lanka Telecom IDC)	416,000	1,210,000	-	1,626,000	-	1,626,000
Local Survey Office (District & Divisional)	83,000	1,497,000	-	1,580,000	-	1,580,000
Installation Fee	403,000		55,000	458,000	-	458,000

Item	EDCF				GoSL	Total
	Foreign Currency		Local Currency	EDCF Total		
	Korea	3rd Countries				
Function and Integration Test	288,000		51,000	339,000	-	339,000
Cost for SLT IDC Usage (Initiation+2 Years)	-	-	-	0	166,000	166,000

[Table Ⅶ-18] Breakdown of Data Center and Operating Infrastructure Project Costs

(Unit: USD)

Classification	Items	Quantity	Cost(USD)	Remarks
IT infrastructure setup	Server & Storage System, etc.	2 sites	1,291,000	
	Network System	2 sites	729,000	
	Security System	2 sites	1,084,000	
	Software License	2 sites	274,000	
Subtotal			3,378,000	
OA equipment	PC N Monitor	2	3,472	
	Scanner	1	620	
Subtotal			4,000	
Data center auxiliary equipment, etc.	Auxiliary equipment	1 site	242,000	UPS, thermo-hygrostat, fire extinguishing equipment, etc.
	Access control system, etc.	1 site	195,915	Computer room construction and access control system and CCTV
	Maritime transportation costs	1 set	7,392	
Subtotal			445,000	
Local survey offices	District survey officers	25 sites	443,000	
	Divisional survey offices	84 sites	1,054,000	
	MCs	24 Sites	83,000	
Subtotal			1,580,000	

Category	Item	Unit price	Quantity (M/M)	Cost	
Installation and integration test	Labor costs	4,729	20.85	98,599.65	Special-class (ICT)
		4,319	14.00	60,466	Advanced (ICT)
		5,230	3.25	16,997.5	Special-class (electrical)

Classification	Items			Quantity	Cost(USD)	Remarks
			5,812	2.25	13,077	Special-class (machinery)
			5,288	2.75	14,542	Special-class (constructio n)
		Subtotal			203,682	
	Overhead expenses	110% of the direct labor costs			224,050	
	Engineering fees	40% of the direct labor costs			81,473	
	Subtotal				509,000	
		International flight airfare (incl. insurance)	1,500	20	30,000	(incl. insurance)
		Domestic flight airfare	230	13	2,990	
		Accommodation costs	2,310	38.25	88,357.5	Accommodatio ns
		Living expenses	1,680	38.25	64,260	Food expenses and daily expenses
		Car rental fees	2,860	18	51,480	
		Visa fees	50	20	1,000	
		Interpreter fees	2,860	18	51,480	
		Subtotal			288,000	
Total					6,204,000	
IDC rental fees for 2 years		6 racks			166,000	
Total					6,370,000	

2.3.3.Annual Project Costs

[Table Ⅶ-19 Breakdown of Annual Project Costs

(Unit: 1,000 USD)

Item	EDCF				GOSL	Y1	Y2	Y3	Total
	Foreign Currency		Local Currency	EDCF Total					
	Korea	3rd Countries							
Total	1,999	4,087	0	6,086		2,439	2,576	1,237	6,252
Main Data Center (SDSL-IT Branch)	821	1,380	-	2,201	-	878	878	445	2,201
Backup Data Center (Sri Lanka Telecom IDC)	416	1210	-	1,626	-	813	813		1,626
Local Survey Office (District & Divisional)	83	1,497	-	1,580	-	790	790		1,580

Installation and Test	691	-	106	797	166		135	828	963

2.4.Consulting Service

2.4.1.Calculation Standards

[Table Ⅶ-20] Consulting Service Project Cost Calculation Standards

Category	Item	Calculation Standards	Note
Labor costs	Direct labor costs	Average wages announcement (2018) KENCA/KOSA/KASM/TTA	Applied individually for each participating technician
	Indirect labor costs	Apply KEXIM guidelines	Overhead expenses: 110% of direct labor costs; Engineering fees: 40% of direct labor costs
	Local labor costs	Provided by the project implementer Field survey	
Direct cost	Airfare, living expenses, office rental fees, etc.	Same as the standards applied for database	

2.4.2.Project Cost Estimation

[Table Ⅶ-21 Consulting Service Project Costs

(Unit: USD)

Major classification	Intermediate classification	Item	Monthly labor unit price (USD)	Quantity (M/M)	Cost (USD)	Remarks
Labor costs (Korean consultants)	Surveying	Special-class technician	4,323.22	36	155,636	Unit price of labor of engineering, software and surveying technicians
		Advanced technician	3,784.44	47	177,869	
	Software	Engineer	8,196.66	48	393,440	
		Special-class technician	7,208.24	28	201,831	
		Advanced technician	5,418.19	39	211,309	
	Communications	Special-class technician	4,728.90	27.75	131,227	
		Advanced technician	4,318.82	32	138,202	

(Unit: USD)

Major classification	Intermediate classification	Item	Monthly labor unit price (USD)	Quantity (M/M)	Cost (USD)	Remarks
	Direct labor costs				1,408,283	
	Indirect labor costs (Overhead expenses + Engineering fees)				2,112,425	Overhead expenses: 110% of direct labor costs; Engineering fees: 40% of direct labor costs
Subtotal					**3,520,708**	
Labor costs (local manpower)	Surveying	Special-class	200	10	2,000	
	GIS	Special-class	200	10	2,000	
	ICT	Special-class	200	16	3,200	
Subtotal					7,200	
Direct cost (business trip expenses of Korean consultants, etc.)	International flight airfare (incl. insurance)		1,450	181 times	262,450	Phase 1: 7 months Phase 2: 5 months Phase 3: 36months
	Domestic flight airfare		230	18 times	41,400	
	Car rental fees		130	465 days	60,450	
	Accommodation costs		77	761 nights	58,597	
	Living expenses (meals and daily expenses)		56	739 days	41,384	
	Visa fees		50	109 times	5,450	
	Interpreter fees		130	375 days	48,750	
	Overhead expenses: 110% of direct labor costs; Engineering fees: 40% of direct labor costs				1,194,181	
Subtotal					1,712,662	
Direct cost (business trip expenses of local personnel, etc.)	Travel expenses		75	36	2,700	
	Business trip expenses		125	36	4,500	
	Transportation expenses		200	36	7,200	
Subtotal					14,400	
Total					4,370,000	

2.4.3.Annual Project Costs

[Table Ⅶ-221 Consulting Service Project Costs by Year

(Unit: Thousand USD)

Item	EDCF				GOSL	Y1	Y2	Y3	Y4	Total
	Foreign Currency Portion		Local Currency Portion	EDCF Total						
	Korea	3rd country								
1) Basic design and bid drafting	1,089		140	1,299		1,229				1,229
2) Evaluation and contract support	462		65	527		527				527
3) Supervision	2,313		301	2,614			784	784	1,046	2,614
Total	3,864		506	4,370		1,756	784	784	1,046	4,370

2.5.Capacity Building

2.5.1.Project Cost Calculation Standards

[Table Ⅶ-23] Capacity Building Cost Calculation Standards

Classification	Item		Calculation basis	Remarks
Invitation Training in Korea	Cost of inviting trainees to Korea	Living expenses (daily expenses, meal costs, accommodations)	KOICA Global Training Guide (CIAT Program)	
		Airfare	Identical to the application standards for the surveying database	
		Insurance	Identical to the application standards for the surveying database	
	Operating expenses	Interpreter fees	KOR-ENG, based on official rate of Hankuk University of Foreign Studies Graduate School of Interpretation and Translation	
		Instructor fees	KOICA Global Training Guide (CIAT Program)	
		Car rental fees, educational material printing costs, etc.	Estimated expenses	

Classification	Item		Calculation basis	Remarks
	Program host	Direct labor costs	KOICA Global Training Guide (CIAT Program)	
		Indirect labor costs	Apply KEXIM guidelines	Overhead expenses: 110% of the direct labor costs Engineering fees: 40% of the direct labor costs
Training for fostering instructors	Direct labor costs	IT network infrastructure	2018 Base Rate for Engineer (Communications)	
		LIS and LISS	2018 Base Rate for Engineer (Communications))	
		Geoinformatics	2018 Base Rate for Software Engineer	
		Data acquisition and surveying	2018 Base Rate for Surveying Technician	
	Indirect labor costs		Apply KEXIM guidelines	Overhead expenses: 110% of the direct labor costs Engineering fees: 40% of the direct labor costs
	Direct Cost	Airfare, sojourn costs, interpretation/translation costs, car rental fees, etc.	Identical to the application standards for the surveying database	
		Trainee expenses	Field survey results provided by project implementer (based on the bus fare for traveling between Colombo and SDSL training center)	
Expansion training for operators	Direct labor costs	IT network infrastructure	2018 Base Rate for Engineer (Communications)	
		LIS and LISS	2018 Base Rate for Engineer (Communications))	
		Geoinformatics	2018 Base Rate for Software Engineer	
		Data acquisition and surveying	2018 Base Rate for Surveying Technician	
	Indirect labor costs		Apply KEXIM guidelines	Overhead expenses: 110% of the direct labor costs Engineering fees: 40% of the direct labor costs
	Direct cost	Airfare, sojourn costs, interpretation/translation costs, car rental fees, etc.	Identical to the application standards for the surveying database	
		Trainee expenses	Field survey results provided by project implementer (based on the bus fare for traveling between Colombo and SDSL	

Classification	Item		Calculation basis	Remarks
			training center)	
OJT	Labor costs	Trainees	Field survey results provided by project implementer (labor costs for local public servants)	GOSL Portion
	Local operating expenses	Workshops, educational material printing costs, etc.	Estimated expenses	

[Table Ⅶ-24] Capacity Building Cost Calculation Standards

Classification	Item		Calculation basis	Remarks
Training infrastructure improvement	Equipment transportation costs	Korea-Port of Colombo (marine transportation)	Multiple quotations from private enterprises	
		Port of Colombo-Training Center (land transportation)		
	Classroom environment improvement	Direct labor costs	2018 Base Rate for Engineer (Construction & Mechanical Equipment)	
		Indirect labor costs	Apply KEXIM guidelines	Overhead expenses: 110% of the direct labor costs Engineering fees: 40% of the direct labor costs
		Direct cost	Identical to the application standards for the surveying database	
	Educational equipment and furniture	Direct labor costs	2018 Base Rate for Engineer	
		Indirect labor costs	Apply KEXIM guidelines	Overhead expenses: 110% of the direct labor costs Engineering fees: 40% of the direct labor costs

2.5.2.Project Cost Estimation

[Table Ⅶ-25] Capacity Building Cost Estimates

(Unit: USD)

Item	EDCF				GOSL	Total
	Foreign Currency Portion		Local Currency Portion	EDCF Total		
	Korea	3rd Countries				
Total	897,000	274,000	469,000	1,640,000		1,947,000
Invitation Training in Korea	339,000			339,000		339,000
OJT (On the Job Training)			64,000	64,000	307,000	371,000
Training for Fostering Instructors	339,000		75,000	414,000		414,000
Expansion Training for Operators	59,000		325,000	383,000		383,000
Improvement of Training infrastructure	160,000	274,000	6,000	440,000		440,000

[Table Ⅶ-26] Detailed Breakdown of Capacity Building Costs

Category		Item	Quantity	Cost (USD)	Remarks
Training in Korea	Session 1	Trainees: Airfare	30 people	43,500	
		Trainees: Living expenses	30 people	93,847	
		Trainees: Insurance	30 people	1,500	
		Interpreter fees	1 person*10 days	9,380	
		Industrial tour	1 set	853	
		Welcome/departure luncheon/banquet	1 set	2,559	
		Instructor fees	3 people*5 days	5,757	
		Educational material printing costs	1 set	853	
		Car rental fees	14 days	5,970	
		Other (refreshments & consumables)	1 set	851	
		Program hosts: Labor costs	Special Class 1 person*5 days Advanced 1 person*14 days Intermediate 1	4,853	Incl. overhead expenses & engineering fees

Category		Item	Quantity	Cost (USD)	Remarks
			person*14 days		
	Subtotal			169,924	
	Session 2	Trainees: Airfare	30 people	43,500	
		Trainees: Living expenses	30 people	93,847	
		Trainees: Insurance	30 people	1,500	
		Interpreter fees	1 person*10 days	9,380	
		Industrial tour	1 set	853	
		Welcome/departure luncheon/banquet	1 set	2,559	
		Instructor fees	3 people*5 days	5,757	
		Educational material printing costs	1 set	853	
		Car rental fees	14 days	5,970	
		Other (refreshments & consumables)	1 set	851	
		Program hosts: Labor costs	Special Class 1 person*5 days Advanced 1 person*14 days Intermediate 1 person*14 days	4,852	Incl. overhead expenses & engineering fees
	Subtotal			169,924	
Total of Invitation Training in Korea				339,000	Thousand USD or less
Training for fostering Instructors	Training on IT network infrastructure	Labor costs	Special Class 1people*44 days Advanced class 1people *44 days	18,095	Engineering (communications)
		Overhead expenses		19,904	110% of the direct labor costs
		Engineering fees7		7,239	40% of the direct labor costs
		Airfare	2 people*1 time	3,000	
		Visa issuance fees	2 people*1 time	100	
		Living expenses	2 people*60 days	15,960	
		Car rental fees	1 car*44 days	5,720	Excl. weekends
		Interpretation/translation fees	1 person*44 days	5,720	Excl. weekends
		Lecture material production costs	1 set	500	
		Meeting expenses	1 set	1,000	

Category		Item	Quantity	Cost (USD)	Remarks
		Consumables	1 set	1,000	
		Trainees: Transportation costs	16 people*1 time	120	
		Trainees: Daily expenses	16 people*60 days	7,200	
	Subtotal			85,558	
	Training on System development	Labor costs	Special Class 2 people*44 days	32,586	Soft Engineer
		Overhead expenses		35,846	110% of the direct labor costs
		Engineering fees7		13,034	40% of the direct labor costs
		Airfare	2 people*1 time	3,000	
		Visa issuance fees	2 people*1 time	100	
		Living expenses	2 people*60 days	15,960	
		Car rental fees	1 car*44 days	5,720	Excl. weekends
		Interpretation/translation fees	1 person*44 days	5,720	Excl. weekends
		Lecture material production costs	1 set	500	
		Meeting expenses	1 set	1,000	
		Consumables	1 set	1,000	
		Trainees: Transportation costs	16 people*1 time	120	
		Trainees: Daily expenses	16 people*60 days	7,200	
	Subtotal			121,788	
	Training on Geomatics	Labor costs	Professional 1 people * 44 days Special Class 1 people*44 days	30,497	Soft Engineer
		Overhead expenses		33,546	110% of the direct labor costs
		Engineering fees7		12,198	40% of the direct labor costs
		Airfare	2 people*1 time	3,000	
		Visa issuance fees	2 people*1 time	100	
		Living expenses	2 people*60 days	15,960	
		Car rental fees	1 car*44 days	5,720	Excl. weekends
		Interpretation/translation fees	1 person*44 days	5,720	Excl. weekends
		Lecture material production costs	1 set	500	
		Meeting expenses	1 set	1,000	
		Consumables	1 set	1,000	

Category		Item	Quantity	Cost (USD)	Remarks
		Trainees: Transportation costs	16 people*1 time	120	
		Trainees: Daily expenses	16 people*60 days	7,200	
	Subtotal			116,561	
	Training on data acquisition and surveying	Labor costs	Special Class 2 people*44 days	20,164	Surveyor
		Overhead expenses		22,179	110% of the direct labor costs
		Engineering fees		8,065	40% of the direct labor costs
		Airfare	2 people*1 time	3,000	
		Visa issuance fees	2 people*1 time	100	
		Living expenses	2 people*60 days	15,960	
		Car rental fees	1 car*44 days	5,720	Excl. weekends
		Interpretation/translation fees	1 person*44 days	5,720	Excl. weekends
		Lecture material production costs	1 set	500	
		Meeting expenses	1 set	1,000	
		Consumables	1 set	1,000	
		Trainees: Transportation costs	16 people*1 time	120	
		Trainees: Daily expenses	16 people*60 days	7,200	
	Subtotal			90,728	
Total of Training for Fostering Instructors				414,000	Thousand USD or less
Expansion Training for Operators	Training on IT network infrastructure	Labor costs	Special Class 1people*10days	2,149	Engineering (communications)
		Overhead expenses		2,364	110% of the direct labor costs
		Engineering fees		860	40% of the direct labor costs
		Airfare	1 people*1 time	1,500	
		Visa issuance fees	1 people*1 time	50	
		Living expenses	1 people*14 days	1,862	
		Car rental fees	1 car*14 days	1,300	Excl. weekends
		Interpretation/translation fees	1 person*14 days	1,300	Excl. weekends
		Lecture material production costs	1 set	500	
		Meeting expenses	1 set	1,000	

Category		Item	Quantity	Cost (USD)	Remarks
		Consumables	1 set	1,000	
		Transportation costs of Sri Lanka Instructor:	4 people*1 time	120	
		Daily expenses of Sri Lankan Instructors	4 people*10days	1,680	
		Transportation costs of Trainee	138 people* 1 time	4,140	
		Daily expenses of Trainee	138 people *14days	57,960	
	Subtotal			77,785	
	Training on system	Labor costs	Special Class 1 person*14 days	3,465	Engineering (communications)
		Overhead expenses		3,812	110% of the direct labor costs
		Engineering fees		1,386	40% of the direct labor costs
		Airfare	1 people*1 time	1,500	
		Visa issuance fees	1 people*1 time	50	
		Living expenses	1 people*14 days	1,862	
		Car rental fees	1 car*14 days	1,300	Excl. weekends
		Interpretation/translation fees	1 person*14 days	1,300	Excl. weekends
		Lecture material production costs	1 set	500	
		Meeting expenses	1 set	1,000	
		Consumables	1 set	1,000	
		Trainees: Transportation costs	4 people*1 time	120	
		Trainees: Daily expenses	4 people*10days	1,680	
		Transportation costs of Trainee	138 people* 1 time	4,140	
		Daily expenses of Trainee	138 people *14days	57,960	
	Subtotal			81,075	
	Training on geoinformatics	Labor costs	Special Class 1 people*14 days	3,465	Software technician
		Overhead expenses		3,812	
		Engineering fees		1,386	
		Airfare	1 people*1 time	1,500	

Category		Item	Quantity	Cost (USD)	Remarks
		Visa issuance fees	1 people*1 time	50	
		Living expenses	1 people*14 days	1,862	
		Car rental fees	1 car*14 days	1,300	Excl. weekends
		Interpretation/translation fees	1 person*14 days	1,300	Excl. weekends
		Lecture material production costs	1 set	500	
		Meeting expenses	1 set	1,000	
		Consumables	1 set	1,000	
		Transportation costs of Sri Lanka Instructor:	4 people*1 time	120	
		Daily expenses of Sri Lankan Instructors	4 people*10days	1,680	
		Transportation costs of Trainee	138 people* 1 time	4,140	
		Daily expenses of Trainee	138 people *14days	57,960	
	Subtotal			81,075	
	Training on data acquisition and repletion surveying	Labor costs	Special Class \ 2 people*40 days	3,930	Surveyor
		Overhead expenses		4,323	110% of the direct labor costs
		Engineering fees		1,572	40% of the direct labor costs
		Airfare	2 people*1 time	3,000	
		Visa issuance fees	2 people*1 time	100	
		Living expenses	2 people*14 days	3,724	
		Car rental fees	1 car*14 days	1,300	Excl. weekends
		Interpretation/translation fees	1 person*14 days	1,300	Excl. weekends
		Lecture material production costs	1 set	500	
		Meeting expenses	1 set	1,000	
		Consumables	1 set	1,000	
		Transportation costs of Sri Lanka Instructor:	4 people*1 time	120	
		Daily expenses of Sri Lankan Instructors	4 people*10days	1,680	
		Transportation costs of Trainee	138 people* 1 time	4,140	

<table>
<tr><th colspan="2">Category</th><th>Item</th><th>Quantity</th><th>Cost (USD)</th><th>Remarks</th></tr>
<tr><td rowspan="3"></td><td></td><td>Daily expenses of Trainee</td><td>138 people *14days</td><td>115,920</td><td></td></tr>
<tr><td colspan="3">Subtotal</td><td>143,069</td><td></td></tr>
<tr><td colspan="3">Total of Expansion Training for Operators</td><td>383,000</td><td>Thousand USD or less</td></tr>
<tr><td rowspan="5">OJT</td><td rowspan="4">Sri Lanka</td><td>Trainees: Labor costs</td><td>6 people *36months</td><td>307,000</td><td>GOSL Portion</td></tr>
<tr><td>Workshop</td><td>1 set</td><td>21,600</td><td></td></tr>
<tr><td>Material printing costs</td><td>1 set</td><td>21,600</td><td></td></tr>
<tr><td>Other (meeting expenses, consumables, etc.)</td><td>1 set</td><td>21,600</td><td></td></tr>
<tr><td colspan="3">Subtotal</td><td>371,000</td><td>Thousand USD or less</td></tr>
<tr><td rowspan="21">Improvement of the Training Environment Infrastructure</td><td rowspan="2">Transportation costs</td><td>Korea-Port of Colombo (marine transportation)</td><td>1 set</td><td>6,000</td><td></td></tr>
<tr><td>Port of Colombo-Training Center (land transportation)</td><td>1 set</td><td>1,000</td><td></td></tr>
<tr><td rowspan="5">Construction labor costs</td><td>Communications facilities</td><td>2 people*14 days</td><td>5,351</td><td></td></tr>
<tr><td>Furniture setup</td><td>1 person*7 days</td><td>1,548</td><td></td></tr>
<tr><td>On-site management</td><td>2 people*14 days</td><td>3,699</td><td></td></tr>
<tr><td colspan="2">Overhead expenses</td><td>11,656</td><td>110% of the direct labor costs</td></tr>
<tr><td colspan="2">Engineering fees</td><td>4,239</td><td>40% of the direct labor costs</td></tr>
<tr><td rowspan="5">Direct cost</td><td>Airfare</td><td>4 people*1 time</td><td>6,000</td><td></td></tr>
<tr><td>Visa fees</td><td>4 people*1 time</td><td>200</td><td></td></tr>
<tr><td>Living expenses</td><td>49 days</td><td>26,068</td><td></td></tr>
<tr><td>Car rental fees</td><td>1 car*14 days</td><td>1,820</td><td></td></tr>
<tr><td>Interpretation/translation fees</td><td>1 person*10 days</td><td>1,300</td><td></td></tr>
<tr><td rowspan="7">Training equipment</td><td>Workstation (27 inch)</td><td>3 ea.</td><td>10,157</td><td>2EA in ISM
1EA in SDSL HQ</td></tr>
<tr><td>Desktop</td><td>5 ea.</td><td>115,134</td><td></td></tr>
<tr><td>Auto CAD</td><td>2</td><td>8,102</td><td></td></tr>
<tr><td>Beam projector</td><td>5 ea.</td><td>16,417</td><td></td></tr>
<tr><td>Electronic screen (120 inch)</td><td>5 ea.</td><td>4,179</td><td></td></tr>
<tr><td>Electronic desk</td><td>5 ea.</td><td>22,984</td><td></td></tr>
<tr><td>Whiteboard</td><td>5 ea.</td><td>5,330</td><td></td></tr>
</table>

Category		Item	Quantity	Cost (USD)	Remarks
		Smart board	5 ea.	35,180	
		Lecture desk	5 ea.	938	
		Printer	2 ea.	1,706	
		Scanner	2 ea.	1,023	
		Plotter (42 inch)	1 ea.	9,381	
		Mobile mic	5 ea.	3,500	
		GNSS receiver and controller	2 ea.	27,291	
		UAV surveying equipment (fixed wing)	2 ea.	81,873	
	Furniture	Chair (with writing panel)	50 ea.	8,528	
		Cabinet (5-tier bookshelves)	4 ea.	512	
	Other	UPS	2 ea.	17,057	
		Building materials	1ea	2,000	
	Subtotal			440,000	Thousand USD or less
Total				**1,947,000**	**Incl. GOSL portion US$307,000**

2.5.3.Project Costs by Year

[Table Ⅶ-27] Capacity Building Costs by Year

(Unit: 1,000 USD)

Item	EDCF				GOSL	Total	Y1	Y2	Y3	Y4
	Foreign Currency		Local Currency	EDCF Total						
	Korea	3rd Countries								
1. Invitation Training in Korea	339			339		339		203	136	
2..OJT			64		307	371		111	130	130
3. Training for fostering instructors	339		75	414		414			414	
Expansion training for operators	59		324	383		383			383	
4. Training environment improvement	160	274	6	440		440			440	
Total	**897**	**274**	**469**	**1,640**	**307**	**1,947**		**314**	**1,503**	**130**

2.6.Operation, Maintenance and Repair Support

2.6.1.Calculation Standards

[Table Ⅶ-28] O&M Support Cost Calculation Standards

Classification	Item	Calculation basis	Remarks
Labor costs	Direct labor costs	KENCA & KOSA	Applied for each participating technician
	Indirect labor costs	Apply KEXIM guidelines	Overhead expenses: 110% of the direct labor costs; Engineering fees: 40% of the direct labor costs
	Local labor costs	Provided by the project implementer / Field survey	
Direct cost	Airfare, living expenses during business trip, office rental fees, et.	Same as the database application standards	

2.6.2.Project Cost Estimation

[Table Ⅶ-29] O&M Support Costs

(Unit: USD)

Major classification	Mid classification	Item	Monthly labor unit price (USD)	Quantity (M/M)	Cost (USD)	Remarks
Labor costs (Korea)	Land and spatial information DB	Special Class-Surveying	4,323	9	38,009	
	System development	Special Class-Software	7,208	9	64,874	
		Advanced Class-Software	5,418	22.5	121,909	
	Data Center	Advanced Class H/W,N/W	4,319	13.5	58,304	
		Advanced Class-IS	4,319	13.5	58,304	
	Mid classification	**Item**	Daily labor unit price **(USD)**	Quantity **(M/D)**	**Cost (USD)**	
	Capacity Building	Advanced Class-Surveying	172	112	19,600	
		Advanced Class	196	112	21,952	

(Unit: USD)

Major classification	Mid classification	Item	Monthly labor unit price (USD)	Quantity (M/M)	Cost (USD)	Remarks
		H/W,N/W				
		Advanced Class-Software	347	112	38,864	
	Indirect labor costs (overhead expenses + engineering fee)				633,551	Overhead expenses: 110% of direct labor costs, Engineering fees: 40% of direct labor costs
	Subtotal of Labor Costs (Korea)				1,055,918	
Labor costs (local)	Special Class-Surveying		1,710	6	19,260	
	Special Class-Software		1,710	24	41,041	
Subtotal of Labor Costs (Sri Lanka)					51,301	
Total of Labor Costs (Korea & Sri Lanka)					**1,107,219**	
Direct cost	International Airfare		1,500	42 times	63,000	
	Living expenses		$1,680 * (57months+336days)		114,576	
	Car rental		($2,860/months * 30 months) + ($130/days*40days)		96,200	
	Accommodation		$2,310 * (57months+288days)		153,846	
	Visa		50	42 times	2,100	
	Document Printing		100		450	
	Interpreter		2,860	18 months & 40days	56,680	
	Spare Part (Data Center)		99,201		99,201	Direct cost of ICT equipments * 2%
Subtotal of Direct Costs					**586,053**	
Total					**1,687,000**	**Thousand USD or less**

2.6.3.Project Costs by Year

[Table Ⅶ-30] O&M Support Costs by Year Standards

Item	EDCF				GOSL	Total	Y1	Y2	Y3	Y4
	Foreign Currency		Local Currency	EDCF Total						
	Korea	3rd Countries								
Support of Land & Spatial Info. DB	136		17	153		153				153
Support of Land Info Sys. Development	584		34	618		618				618
Support of Data Center and Infra	409	78	86	573		573				573
Support of Capacity Building	276		16	293		293				293
Support for local staff			51	51		51				51
Total	**1,405**	**78**	**204**	**1,687**		**1,687**				**1,687**

2.7.PMU

2.7.1.Standard

[Table Ⅶ-31] PMU operating cost calculation standard

Cost	Category	Calculation Standard	Remarks
Labor cost	Direct labor	Local consultant research	Sri Lanka average salary per filed/skill
Direct cost	Car rental, domestic travel cost	Local research	

2.7.2.Yearly cost

[Table Ⅶ-32] O&M Support Costs by Year Standards

Item	EDCF				GoSL	Y1	Y2	Y3	Y4	Total
	Foreign Currency		Local Currency	EDCF Total						
	Korea	3rd Country								
1) Labor cost					410	102	102	103	103	410
2) Direct cost					270	67	67	68	68	270
Total					**680**	**169**	**169**	**171**	**171**	**680**

2.8.Taxes and Public Utilities' Charge

- Based on the Sri Lankan Tax regulations, the tax occurred from the implementation of for t he land information system project has been estimated with the direct cost of the total EDC F project cost, excluding labor costs.

- The taxes and public utilities were calculated as follows: Value Added Tax (VAT) of 15%; Port and Air Port Development Levy (PAl) of 7.5%; and Nation Building Tax (NBT).

- Customs duties are calculated based on the HS Item Classification Table of 2012 (HS2012). Duties are differentially applied according to 6,965 item categories (8 digits). Approximatel y 50% of them are subject to no duties (0%), which makes up the largest portion, followed by customs duty rate of 30% at 23% and customs duty rate of 15% at 20%.

- Therefore, the project will apply an average tariff of 10.3% based on the WTO Trade Polic y Review (TPR-347, Sept. 27, 2016).

[Table Ⅶ-33] Details of the Taxes and Duties

(Unit : USD)

Item	Estimation Basis	Cost	Remarks
Equipment Cost of EDCF		12,304,000	Taxes and duties (including VATs, levies, etc.) arising under Sri Lanka's internal laws and regulations are tax exempt.
VAT	15% of EDCF Equipment Cost	1,845000	
PAL	7.5% of EDCF Equipment Cost	923,000	
NBT	2.03% of EDCF Equipment Cost	250,000	
Custom Duties	10.3% of EDCF Equipment Cost	1,267000	
Total		4,285,000	

2.9.Contingency

- Contingency is a budget allocated to prepare for an increase in the project costs due to a di fference in the cost between the time the project budget was calculated and the time at whi ch the project is executed. It is comprised of physical contingency and price contingency.

2.9.1.Physical Contingency

- Physical contingency is the contingency allocated for potential changes in the quantity result ing from project materialization (working design), specification change, design change in pr oject execution period, etc.

- Physical contingency is set at 5% of the direct cost in accordance with the EDCF Continge ncy Calculation Criteria (November 22, 2011.)

2.9.2.Price Contingency

❍ Price contingency is allocated in preparation for a potential increase in project costs due to unexpected price fluctuations such as inflation and exchange rate fluctuations.

❍ The average CPI (Consumer Price Index) over the last three years and the inflation expected during the 12 months of preparation for the project and 36 months of project implementation were considered.

– Preparations for the project: 12 months
– Project implementation: 36 months

Source: International Monetary Fund, World Economic Outlook Database, April 2019

[Table Ⅶ-33] Average Inflation (2016~2018)

Category	2016	2017	2018	Average inflation
World average	2.76%	3.20%	3.64%	3.20%
Sri Lanka	3.99%	6.58%	4.27%	4.95%
Republic of Korea	0.97%	1.94%	1.48%	1.47%

[Table Ⅶ-34] Average Inflation Projections (2020~2023)

Category	2020	2021	2022	2023	Average inflation
World average	3.20%	6.50%	9.91%	13.43%	6.61%
Sri Lanka	4.95%	10.15%	15.60%	21.32%	10.40%
Republic of Korea	1.47%	2.96%	4.48%	6.01%	2.98%

Source: International Monetary Fund, World Economic Outlook Database, April 2019

2.9.3.Calculation of Contingency

[Table Ⅶ-35] Calculation of Contingency

(Unit: USD)

Item	EDCF				GOSL /SDSL	Total
	Foreign Currency Portion		Local Currency Portion	EDCF Total		
	Korea	3rd Countries				
Physical contingency	1,035,000	485,000	913,000	2,433,000		2,433,000
Price contingency	648,000	807,000	2,246,000	3,701,000		3,701,000
Total	1,683,000	1,292,000	3,159,000	6,134,000		6,134,000

2.10.Loan Handling Fee

❍ Sri Lanka belongs to Group III of the Upper Middle Level based on income level, according to the World Bank. Accordingly, 0.1% of the sum of the direct cost and contingency of the EDCG project and contingency was reflected as the loan handling fee.

Ⅷ. Project Feasibility Analysis

1.Policy Feasibility Analysis

1.1.Policy Feasibility Analysis

❍ The Policy feasibility analysis of the Sri Lanka land information system construction project shall apply the policy evaluation criteria of the 「Standard Guidelines for Conducting Preliminary Feasibility Studies for Overseas Projects in Public institutions. (2013), Korea Development Institute」.

– First, the evaluation of the conformity with the national policy and higher-level plans

– Secondly, evaluate the willingness and preferences of the recipient countries for their projects.

– Thirdly, the necessity of projects based on national policy and willingness to promote projects.

– Lastly, the risk factors predicted in the project implementation are analyzed for policy feasibility evaluation.

[Table Ⅷ-1] Policy Evaluation Criteria

Evaluation Criteria	Details
Consistency with National Policies and Relevant Upper Level Plans	- Review consistency with national institutions and policy directives - Evaluate whether the project appropriately reflects the upper level plans or other relevant plans
Project Willingness and Preference	- Evaluate attitude and willingness of project conducted by managing department and overseas business related departments
Project Necessity	- Determine specificity, personnel, resource input of project

1.1.1.Consistency with National Policy and Higher-Level Plans

❍ Sri Lanka has established and implemented a policy to introduce e-Government projects and prepare them to provide interactive services to government departments and the public by 2020. For this, 'Re-engineering Government' is selected as the top priority and concentrated support.

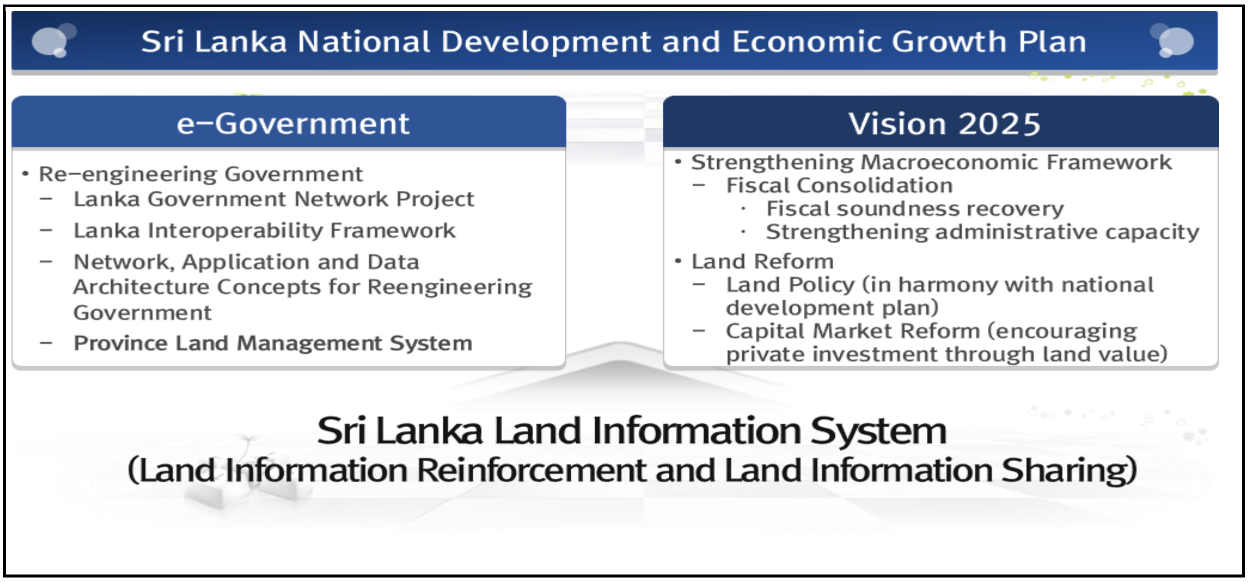
❍ The Provincial Land Management System (PLMS) is selected from 30 major tasks for re-engineering government, and the national policy that emphasizes the importance of land management is in progress.

❍ In addition, as part of the government's business improvement, the Vision 2025, a national development plan, was established to promote ICT technology for national land management.

❍ Fiscal consolidation through land reform is a primary means of strengthening the macro-bor der framework and is a priority for Sri Lankan national policy and planning.

❍ Sri Lanka intends to activate land transactions based on clear land information and secure national financial soundness, such as securing tax revenues based on transparent land transactions.

❍ In addition, the main task is to revitalize the secondary economy and strengthen administrative capacity to support it through land registration and transparent land transactions.



[Figure Ⅷ-1] Consistency With National Polic

❍ The Sri Lankan government seeks to achieve a macroeconomic framework by focusing on the modernization of land data, management of land-related administrative tasks, consistency with national spatial information, and the joint utilization of land-related information. For this purpose, the land information system is to be established first through foreign investment or loans.

❍ This policy foundation is based on the Spatial Information System for the administrative capacity of the Sri Lankan government, and is promoting “decision making and sustainable development through effective use of spatial information”.

❍ SLSDI is being promoted as a national core project to enhance the value of spatial information in the whole society through raising awareness of spatial information technology, capacity building, research and innovation.

❍ The activation of land transactions in the social and economic aspects and the achievement of the macroeconomic framework at the policy level establishes the policy direction to develop into national services reflecting the direction of ICT development based on land information and national land information.

❍ Therefore, the land and national spatial information system based on land information of Sri Lanka is becoming a major national project beyond the social, economic, and policy dimensions, and will play a role as a medium for stimulating Sri Lanka's next-generation econom y.

- This project provides “computerization of land data” and “land administration business unifi cation system” and establishes a joint utilization system of land information. Therefore, This project is not only compatible with Sri Lanka's national development plan, but also with th e relevant plans in each sector. It is in line with e-Government architecture, because the La nd Information System (LAS & LISS) of SDSL, which is established through the project, p rovides service to governments and citizens using internal land information through a single portal and makes government services as efficient, convenient and friendly.

- In addition, it is consistent with the policy stance on the establishment of the information in frastructure, environment development, ICT human resource development, and government modernization, which are the core strategies of ICTA, through the expansion of the appropri ate curriculum and the capacity building of professional manpower.

1.1.2. Project Willingness and Preference

- As part of the national development plan, Sri Lanka is focusing on improving the efficiency of administrative work by improving the work on land registration rates.

- More than two-thirds of Sri Lanka's land is nationally managed. Therefore, in order to pro mote secondary economic growth through private land, such as national land development b y private capital, land registration is induced along with private transfer of state-owned land. However, land registration rate is very low at around 5%, so improvement is needed.

- Although the Ministry of Land and Parliament Reform has implemented a new land certific ate issuance system through the Bim Saviya Programme, it has not been able to maintain th e intention of implementing the system because internal and subsidiary business systems are not systematically established.

- Sri Lanka has a strong commitment to build “Sri Lanka Land Information System” to achie ve e-Government and Vision 2025 are based on pre-emotive computerization of land inform ation such as the current land use status as well as the systematic system for improving lan d registration rate. It includes shortening of process time and joint use of related agencies f or land information

- The firm commitment to building Sri Lanka's land information system can be confirmed by MoLPR's diversified efforts to proceed as soon as possible with the help of Korea and the world's advanced countries (US, etc.).

- Since 2016, the land information system construction project proposed by Trimble of the U nited States has been proactive in pursuing the central government level, which can be conf irmed as the first priority system that best matches the Sri Lankan national development pla n.

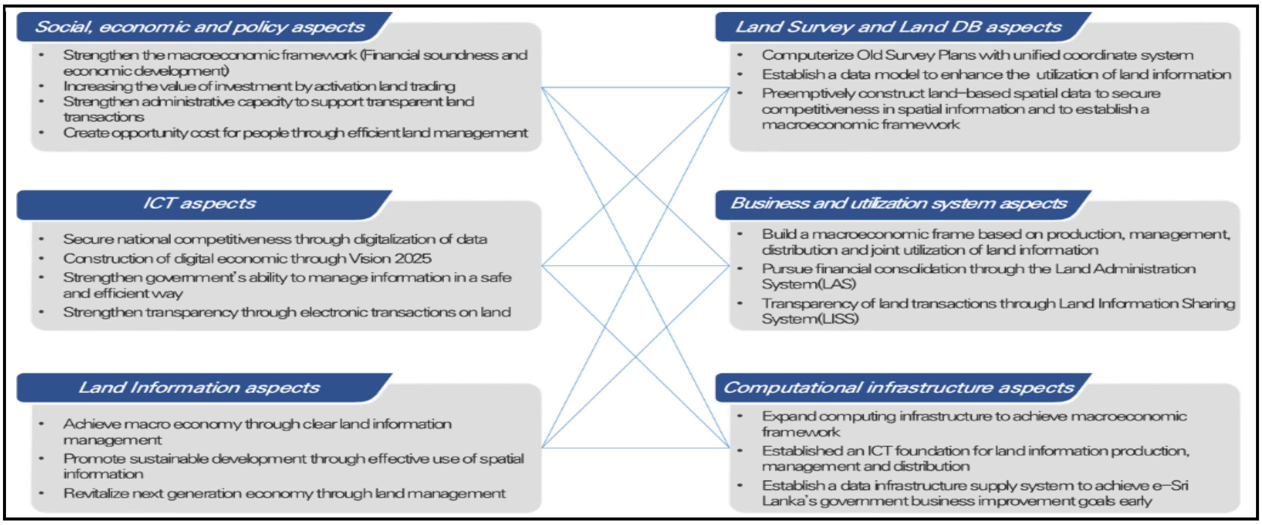
- Trimble's land information system construction project in the United States is planned to pr ovide Sri Lanka land information by foreign engineers while providing large-scale equipmen t. The project raised questions about the role of Sri Lankan surveying engineers.

❍ In addition, the Survey Council, which protects the rights of Sri Lanka's surveying engineers, caused a backlash, which caused severe backlash due to the inability to localize Sri Lanka based on technical support. It was the opportunity to confirm the strong will and preference of “localization”.

❍ Sri Lanka's land information system is being promoted by the strong commitment of MoLPR, the relevant agencies and the surveying agencies responsible for practical responsibility. Ongoing consultations.

❍ Also, the project provides computerization of existing land information, land administration system, land information sharing system, and related infrastructure. It is composed not only by the participation of Korean technicians but also by localization by improving technology of local engineers in Sri Lanka. In addition to Survey Department of Sri Lanka, Ministry of Lands Parliamentary reforms and Municipal Councils also give preference to projects.

❍ Therefore, the Sri Lanka government hopes that the establishment project of Sir Lanka land information system through Korea's EDCF will be launched sooner (They hope to launch it in 2020), and Sri Lankan related ministries are actively paying attention and efforts, which makes it highly feasible in terms of the willingness and preference of Sir Lanka.



[Figure Ⅷ -2] Evaluation on Project Necessity

1.1.3.Project Necessity

❍ This project has strong willingness and preferences from recipient agencies and related ministries, based on the coherence in Sri Lanka's policy, and this necessity can be derived based on the relationship between the present status survey and the target project.

❍ This project implies the necessity to achieve the following core values:

① Seamlessly construct land information

② Raise the efficiency of land administration through land information

③ Enable joint use of land information

④ Re-engineering Government through joint use of land information

⑤ Promote land transactions through land information

⑥ Innovate land value through the promotion of land transactions

⑦ Strengthen the competitiveness of Sri Lanka on the international stage through land value innovation

2.Analysis of adequacy of Project Target

2.1.Appropriateness of Project Scope

- This project is a Sri Lanka land information system construction project, "Administrative Support System for Land Registration", "Management System of Related Data for Land Registration", "Integrated System for Continuously Updating Land-related Data", and "Shared system that can use land information jointly by institution and local government" is the core.

- In addition, it includes computerization of existing survey plans, 50cm satellite orthoimage production for the nationwide of Sri Lanka, and additional CORS Network installation for smooth DB construction of land information.

- In order to facilitate the administrative use and sustainable development of land information system, it is divided into database and system sectors, and includes essential elements, and has a foundation for continuous development through pre-emptive system establishment.

- In terms of data acquisition and management of land information, it is possible to shorten the survey time for land registration by computerizing existing survey plans throughout Sri Lanka. In addition, by using 50cm satellite orthoimage to join each survey plan into a unified coordinate system, it lays the foundation for preemptively building the necessary graphic cadaster.

- By expanding the CORS Network, which is only piloted in Western Province, throughout Sri Lanka, it is possible to lay the groundwork for universal use of new technologies for land surveying, and save time and costs for acquiring various spatial information such as land survey.

- In terms of the system that manages and utilizes land information, the on-line system is introduced from the land information acquisition stage, and it includes a function of smoothly linking internal and external tasks. In addition, it is configured to enable real-time business connection in the acquisition and management of land information.

- The system of land registration process by Bim Saviya Program is systemized so that the stages of off-line administrative processing are on-line to maximize the efficiency of administrative tasks and to obtain the effect of improving government tasks in terms of public service.

- A land information sharing system will be established to enable local governments as well as related organizations that use land information to secure systemicity of land-related work from the central government to local governments.

- In order to maximize the linkage of these tasks, the space DB by UAV aerial photogramme try is constructed for 24 major local governments, which is configured to satisfy the purpos e of this project at the national level.

- Therefore, the data construction and system development sectors of this project should be th e first priority under the policy of Sri Lanka. In addition, it has a business scope considerin g the continuous development of Sri Lanka land information system, so that both its effecti veness and sustainability are satisfied.

2.2.Appropriateness of Area Targeted for Project

- In the data construction section of this project, target areas are defined by four major projec ts.

- First, the computerized area of the Old Survey Plans covers 82,303 sheets included in "Wh ole Sri Lanka".

- The Old Survey Plans consists of a total of 3,275,622 parcels, and because the 50cm satelli te orthoimage is used for geo-referencing the Old Survey Plans, it is composed of computer ized volumes for each parcel within the project period.

- The second part is the 50cm satellite orthoimage production for the geo-referencing of the e xisting survey plans.

- Considering the characteristics of satellite image acquisition, it is possible to acquire 50cm satellite images and produce orthoimages within one year for all Sri Lanka.

- The third is to expand the CORS Network, which is only piloted in the Western Province r egion, to nationwide of Sri Lanka, with 32 additional CORS installations.

- When installing CORS Network for the first time, long time data acquisition and data proce ssing is required to obtain precision coordinates, but six CORS Networks are already in ope ration in Sri Lanka. When 32 additional GNSS Stations are installed, the time required for determining precise coordinates by connecting with the existing network can be greatly redu ced. Therefore, 32 additional CORS installations, accurate coordinates acquisition, and VRS services available within one year.

- The addition and installation of 32 CORS Networks are expected to be highly usable and s ustainable, and the selection of project areas for the entire Sri Lanka is very appropriate.

- Fourth, UAV aerial photogrammetry, data processing, and spatial DB construction based on UAV orthoimages for 24 major MCs are targeted at a total of 708.02㎢, which is considere d to be a very important project for sharing land and spatial information.

- The area of the covered area is 708.02㎢, which covers a rather large area. However, if fix ed-wing UAV is used, it can be carried out within the project period.

- In addition, it is configured to enhance the utility of the work by inputting not only Korean engineers but also local engineers for UAV survey. As a result of reviewing the UAV surv ey plan, it is considered that the plan will minimize the accessibility and mobility of the targe t area

- On-site complementary surveys of parcel boundary, building boundary and street boundary points, which are not extracted from UAV orthoimages, are planned after CORS installation and VRS services are available throughout Sri Lanka. Since the on-site complementary sur vey is composed of connected surveys using UAV orthoimages, the time required for the o n-site complementary survey is not expected to be large.

- Therefore, UAV survey and on-site complementary survey for 708.02㎢ of 24 major MCs c an be carried out within the project period, and the target area is appropriately composed.

- 1 data center, 1 backup center, and environment and facility improvement of 25 district sur vey offices are designed to satisfy both the current work process and the future work load. The 25 district survey offices cover the whole of Sri Lanka, centered on the location of the data center, so the coverage and area are appropriately organized.

- The expansion of the network environment for 84 divisional survey offices under 25 district survey offices maximizes practical work efficiency, which is considered to be appropriate.

3.Technical Feasibility Analysis

3.1.Applied Technology

- This project is a key informatization project for land information management in Sri Lanka that is centered on building integrated technology such as database construction technology for effectively building land information, system development and operation technology for efficiently managing land information, and communication network and related infrastructure technology. Each element technology must interact with each other in an organic manner.

- Accordingly, for the purpose of technical feasibility analysis, the feasibility was verified by analyzing the effectiveness of the application of the proposed core technologies based on m arket maturity and ease of implementation in relation to each core technology.

- Through this analysis, it is analyzed whether the technology applied to the project is a limit ed technology or a technology that is difficult to apply. The project identifies whether the t echnologies can be localized in Sri Lanka.

3.1.1.Technology for Land and Spatial Information DB

- Database construction technology can be classified into core technology associated with the computerization of old survey plans and spatial information database construction technolog y for the 24 municipal councils (MCs).

❍ The core technology concerning computerization of old survey plans is 50cm satellite image production technology for geo-referencing the scanned survey plans based on a unified coo rdinate system, the technology of reference point extraction for geo-referencing from satellit e images, technology for digitizing parcel boundaries on geometrically corrected drawings, a nd spatial database construction technology.

❍ The core technologies concerned in the construction of spatial databases for the 24 MCs are categorized into UAV survey technology, On-Site complementary survey technology, and s patial database construction technology. UAV survey technology includes flight planning, U AV flight and sensor data acquisition technology, image processing technology, and technol ogy for extracting boundaries of parcels (incl. buildings and streets) using UAV orthoimage s.

❍ Core technologies for the additional installation of CORS Network that can promote univers alization of GPS survey technology throughout Sri Lanka are categorized into VRS correcte d data generation technology and VRS survey technology.

[Table Ⅷ-2] Technology for Land and Spatial Information DB

Target project	Element technology	Market maturity	Ease of implementation
Computerization of old survey plans	50cm satellite orthoimage production technology	Completion (Specialized) Stage	Specialized (Average)
	Reference point extraction technology for geo-referencing based on satellite orthoimages	Completion (Mature) Stage	Universalized (Easy)
	Parcel boundary digitizing technology	Completion (Mature) Stage	Universalized (Easy)
	Spatial database construction technology	Completion (Specialized) Stage	Specialized (Easy)
Construction of spatial database for each of the 24 MCs	UAV flight planning technology	Completion (Specialized) Stage	Specialized (Average)
	UAV flight and sensor data acquisition technology	Completion (Specialized) Stage	Specialized (Average)
	UAV image processing technology	Completion (Specialized) Stage	Specialized (Average)
	Parcel (building & street) boundary extraction technology	Completion (Mature) Stage	Universalized (Easy)
	On-Site complementary survey technology	Completion (Specialized) Stage	Specialized (Easy)
	Spatial database construction technology	Completion (Specialized) Stage	Specialized (Easy)
Additional installation for CORS Network	VRS corrected data application technology	Completion (Specialized) Stage	Specialized (Easy)
	VRS survey technology	Completion (Mature) Stage	Specialized (Easy)

- Technology for LIS construction

- The development of land information systems is based on the development of open source programs to minimize dissemination and maintenance costs. Globally, open source-based GIS systems have been proven to be technically stable and are used in many sites, and web GIS system components based on open source-based GeoServer, Open Layers, Apache, and Tomcat are interoperable with existing systems and it was confirmed that there is no problem in compatibility, and it meets the system requirements for continuous and stable maintenance by applying the open source based solution, not Sri Lanka's exclusive license

- The map editing program is developed based on the standalone method using GDAL/OGR, GeoTools library, and the map inquiry program is developed based on the Web GIS method using GeoServer, Open Layers.

- The field survey system is a mobile system developed in the Android method based on the Java programming language.

- The database that will be applied is the Oracle database which is efficient when it comes to looking up large amounts of spatial information and has a stable connection with the existing database of SDSL.

- Agile methodology will be applied to development in consideration of the fact that the project involves developing systems in remote areas.

[Table Ⅷ-3] System Construction Technology

Category	System	Element technology	Development language
Stand-alone method	Cadastral management system Surveying results preparation system Surveying inspection system	GDAL/OGR GeoTools	C# JAVA
Web method	Land registration system Document management system Surveying application information management system Land information inquiry system Management system Channel system Land Information Service System	GeoServer Open Layers Apache Tomcat	JAVA JSP JavaScript
Mobile	Field surveying system	Android software development kit (SDK)	JAVA

3.1.2. Data Center and Infrastructure Construction Technology

❍ The technical standards for data centers and infrastructure are refer to the Telecommunication Industry Association's (TIA-942) Data Center Standards Overview (TIA-942) and apply technical details which is met with User’s Needs and site conditions.

❍ The categories are divided into high availability, operational flexibility, and reliability according to the equipment conditions such as composition and application in relation to the following items and they are categorized into four levels:

– Network architecture
– Electrical design
– File save, backup and storage
– System redundancy
– Network access control and security
– Database management
– Web hosting
– Application program hosting
– Content distribution
– Environmental management
– Protection against physical hazards (fire, flood, or storm)
– Power management

❍ The highest class (Tier Level 4) requires dual power units for the IT equipment as well as cooling units.

❍ Similar classification criteria include four tier definitions of the Uptime Institute, with each level having the following requirements:

– Tier Ⅰ: 99.671% uptime (availability) and up to 1,729 minutes of downtime per year due to lack of redundancy
– Tier Ⅱ: 99.741% uptime and 1,361 minutes of downtime per year as a result of partial redundancy in key equipment
– Tier Ⅲ: Need to add more data paths, have redundant equipment and supply redundant power to all IT equipment (uptime: 99.982%, annual downtime: 95 minutes)
– Tier Ⅳ: All cooling equipment uses independent redundant power; 99.995% uptime with less than 26 minutes of downtime per year with the addition of fault tolerance.

❍ The technology reviewed and applied to build Sri Lanka land information system applies the following requirements of the data center standard (TIA-942).

– Stage 3: Redundancy of power and cooling facilities (uninterruptible power supply).
– Stage 4: Operational Room, Information Security Technology, Security Facility, Backbone and Network Redundancy, Virtualized Server Technology

- In addition to this, there is a technology introduced to improve the work environment of the local offices, but instead of applying the latest technology, compatibility was chosen as the focus in the feasibility study for integration and optimization with the government network that is currently in operation and being monitored.

[Table Ⅷ-4] Data Center and Infrastructure Construction Technology

Target project	Element technology	Market maturity	Ease of implementation
Data Center (Main & Backup)	Network construction technology	Completion (Mature) Stage	Specialized (Easy)
	Server virtualization technology	Completion (Specialized) Stage	Specialized (Average)
	DR (Disaster Recovery)	Completion (Specialized) Stage	Specialized (Average)
	Storage Area Network	Completion (Specialized) Stage	Specialized (Easy)
Information Security System	Intrusion detection technology	Completion (Specialized) Stage	Specialized (Average)
	Intrusion prevention technology	Completion (Specialized) Stage	Specialized (Average)
	History inquiry technology	Completion (Specialized) Stage	Specialized (Average)
Data Center Environment Development	Power supply	Completion (Mature) Stage	Universalized (Easy)
	Temperature and humidity control	Completion (Mature) Stage	Universalized (Easy)

3.2.Appropriateness of the Applied Technology

- Based on the maturity of the Korean market and the ease of implementation of each core element technology, the effectiveness of the technology in relation to the amount of investment and the possibility of localizing the technology were analyzed.

- The effectiveness of the technology against investment was analyzed based on whether it would be possible to achieve the target/goal within the project period using technology in question and how cost-effective it is compared to other technologies.

- The possibility of localization was analyzed based on the technical difficulty of the technology and the competency level of the Sri Lankan staff. The appropriateness of applying the technology in question was then assessed by determining whether it could continually be applied to the land information processes in Sri Lanka.

- To determine whether the technology is suitable for achieving the goal within the project promotion period, the appropriateness of the technology is judged by analyzing the effect of the application on the project period and the completeness according to the goal achievement.

- In addition, based on the requirements of the project implementation agency, the appropriate technology is analyzed to meet the requirements, and the comprehensive application technology is judged as appropriate.

3.3.Construction of Land and Spatial Information DB

❍ The technologies applied to the database construction are divided into technologies related to the production of 50cm satellite orthoimages, technologies related to the computerization of existing survey plans, technologies related to the construction of spatial DBs for 24 major MCs, and technologies related to CORS installation. Appropriateness of technology analyzes market maturity, ease of implementation, investment effectiveness and localization of core technologies included in each process.

[Table Ⅷ-5] Construction Technology for Land and Spatial Information DB Construction

◎ Very high, ○ High, △ Average, × Low

Target project	Element technology	Market maturity	Ease of implementation	Investment effectiveness		Possibility of localization		Appropriateness
				Attained by the end of the period	Cost aspect	Ease of localization	Local competency	
50cm satellite orthoimage production technolog		◎	○	◎	◎	×	×	○
Computerization of old survey plan	Reference point extraction technology for geo-referencing based on satellite orthoimages	◎	○	◎	◎	○	△	○
	Parcel boundary digitizing technology	◎	◎	◎	◎	○	○	◎
	Spatial database construction technology	◎	○	◎	◎	△	△	○
Construction of spatial database for 24MCs	UAV flight planning technology	○	○	○	○	○	△	○
	UAV flight and sensor data acquisition technology	○	○	○	○	△	×	○
	UAV image processing technology	○	○	○	○	△	×	○
	Parcel (building & street) boundary extraction technology	◎	◎	◎	◎	○	○	◎
	On-Site Complementary Survey technology	○	○	△	△	○	△	○
	Spatial database construction technology	◎	○	◎	◎	△	△	○
Additional installation for CORS Network	VRS corrected data application technology	◎	△	◎	◎	△	×	○
	VRS survey technology	◎	◎	◎	◎	◎	○	◎

- The 50cm satellite orthoimage production technology utilizes the universal technology of the co mpletion stage, which has high market maturity and ease of technology. In addition, it takes abo ut 8 months to produce 50cm satellite ortho images throughout Sri Lanka, and it is a very appr opriate technology because it has superior time and cost competitiveness compared to aerial surv eys.

- In computerizing existing survey plans, the technique of extracting the ground coordinates o f the reference point for geometric correction from the 50cm satellite orthoimage is to utiliz e the universal technology of the completion stage. In addition, it is more suitable for achie ving business goals and requirements with more effective technology in terms of time and c ost than acquiring reference point coordinates by local survey.

- The spatial database construction by UAV survey is a universal, specialized and mature tec hnology in the Korean market. The appropriateness of applying the UAV survey technology of Korea to build a spatial database for the MCs in Sri Lanka was found to be high. The maturity and competency in relation to Sri Lanka's local UAV survey technology are inade quate, but in case of pursuing capacity building in an ongoing manner during the project pe riod, the technology will have very high utility in Sri Lanka as a sustainable survey technol ogy.
  - In Korea, the "Regulation of Public Survey Work using UAV" has been redefined and is used for large scale mapping, image mapping, and 3D spatial information construction.
  - In addition, there is an institutional basis for using UAV observation data in special laws and cadastral surveys on cadastral reinvestigation projects, and UAV is used in related projects.

- VRS correction data application technology and VRS survey technology based on additional CORS installation have been piloted and operated by 6 orders of CORS in Sri Lanka. It is a very useful technology in terms of cost-effectiveness by ensuring the ease of operation a nd compatibility by extending the existing CORS equipment and systems nationwide.

3.3.1. Land Information System

- The LAS required by the recipient country is an online system linked with the central gove rnment, the SDSL, and the local government. The LISS is a public service system that can be accessed by the general public in wherever and whenever. Base on those concept, it is r easonable to construct a web system that can be distributed to all users by updating the ser ver

- For the management of the uncertainty of requirements due to the characteristics of system development developed remotely, development of priority functions required by recipient co untries, and frequent communication to meet the requirements of recipient countries as well as increase the productivity of development teams, agile development methodology is appr opriate to complete the final product in a timely manner

- The web GIS system currently used in Sri Lanka was developed using Java and XML as d evelopment tools based on open source-based GeoServer, Open Layers, Apache, and Tomca t. Therefore, it will unlikely have any compatibility problems when it comes being incorpor ated into the development environment of the software solution that is set to be developed.

- There are no technical constraints concerning new development and interoperability from three aspects: technical maturity, ease of implementation, and technical relevance. It has also been confirmed that there are no technical problems when it comes to, trend conformity, and interoperability among systems for the applied technology

[Table Ⅷ-6] System Construction Technology

◎ Very high, ○ High, △ Average, × Low

Category	Element technology	Market maturity	Ease of implementation	Investment effectiveness		Possibility of localization		Appropriateness
				Attained by the end of the period	Cost aspect	Ease of localization	Local competency	
Stand-alone system	GDAL/OGR	○	○	○	○	×	×	○
	GeoTools	○	○	○	○	×	×	○
Web system	GeoServer	◎	◎	◎	◎	△	△	○
	Open Layers	◎	◎	◎	◎	△	△	○
	Apache, Tomcat	◎	◎	◎	◎	△	△	○
Mobile system	Android software development kit (SDK), JAVA	◎	○	○	○	△	△	○

3.3.2.Data Center and Infrastructure

❍ ICT technologies for the construction of Data Centers and Infrastructure are analyzed for ad equacy based on international technology trends, Sri Lanka's universality and the stability a nd reliability of the systems to be provided.

[Table Ⅷ-7] 39 Technical Appropriateness of the ICT Setup

◎ Very high, ○ High, △ Average, × Low

Target project	Element technology	Market maturity	Ease of implementation	Investment effectiveness		Possibility of localization		Appropriateness
				Attained by the end of the period	Cost aspect	Ease of localization	Local competency	
Data Center (Main & Backup)	Network construction technology	◎	◎	◎	◎	◎	○	◎
	Server virtualization technology	○	○	◎	◎	△	△	○
	DR (Disaster Recovery)	○	○	◎	◎	△	△	○
	Storage Area Network	◎	◎	◎	◎	○	△	◎
Information Security System	Intrusion detection technology	○	○	○	○	○	△	○
	Intrusion prevention technology	○	○	○	○	○	×	○
	History inquiry technology	△	○	○	○	○	×	○

Data Center Environment Development	Power supply	◎	◎	◎	◎	◎	◎	◎
	Temperature and humidity control	◎	◎	◎	◎	◎	◎	◎

❍ The technologies applied to the data center construction for the Sri Lankan land information system are as follows.

– Backbone and Network Redundancy
– Data Storage Facilities (Disk Array & Virtual Tape Library)
– WAS / WEB Server and Virtualization Technology
– Information Security Technology,
– Security facilities
– Operational Room for O&M

❍ Improved operational reliability of the system by changing the existing single-entry optical cable into redundancy and redundant network facilities such as backbone and L4 / L7 switc h and information security facilities.

❍ Secure operational continuity by configuring hot sites through periodic data synchronization between the main and backup data centers.

❍ Improve operational efficiency by providing adequate storage space for operating and separa te storage of basic data.

❍ Secure operational continuity by configuring hot sites through periodic data synchronization between the main and backup data centers.

❍ The synchronization cycle is conducted twice a day, including once at night time due to lo w access to the system, and the synchronization time for day time should be adjusted to tak e into account the user's actual access frequency

❍ Improve operational efficiency by providing adequate storage space for operating and separa te storage of basic data.

– Storage Capacity for LAS : 300TB (Physical Usage 157.74 TB, 30% Spare and 40% for RAID configuration)
– Storage Capacity for LISS : 100TB (Physical Usage 49.99 TB, 30% Spare and 40% for RAID configuration)
– Storage Capacity for Basic information : 200TB (Physical Usage 104.58 TB30% Spare and 40% for RAID configuration)

❍ In order to prevent the emergency situation with power supply and ensure operational conti nuity, Constant power and emergency power (40KW Generator with fuel tank for 1 day op eration) are considered. And ATS & UPS(50 KVA, 30 minutes backup time for emergency power change) would be provided to use during the automatic transfer from constant Power to Generator power.

- The bandwidth increase at the District Survey Office will be applied in accordance with LGII's Bandwidth Change Policy Based on Usage, a subsidiary of ICTA.

- The introduction of LGN 2.0 at the Divisional Survey Office has been planned in LGII's government network expansion plan, but it is unclear when it will be conducted for the lower level organization. Therefore it has agreed to accelerate the implementation time by supplying hardware in the project, based on the discussion with the relevant organizat ion (LGII).

- The construction of optical cables and supplement of network connectivity for divisional survey office had been discussed with SLT, the government network operator.

- In accordance with the above, the technology was applied in a way that could take into acc ount the requirements of the surveying authority, which is the operator of the Sri Lanka lan d information system, and secure stability and reliability.

4.Analysis of the Appropriateness of the Project Costs

4.1.Project Cost Composition

- When the cost of Sri Lanka LIS project is categorized into seven major classifications, and the costs can be divided according to the source of the financial resources: the Republic of Korea, a third country, and the recipient country, Sri Lanka.

- The total project cost is estimated at USD 60,330,000, with a direct project cost of USD 49, 857,000. Contingency and taxes are estimated to be USD 10,473,000.

[Table Ⅷ-8] Project Cost Composition

Area	Project cost (1,000 USD)	Rate	Remarks
Construction of Land and Spatial Information DB	26,263	43.54%	
LIS construction	8,540	14.16%	
Data center and infrastructure construction	6,370	10.56%	
Capacity building	1,947	3.23%	
Consulting	4,370	7.25%	
O&M support	1,687	2.80%	
PMU	680	1.13%	
Total direct cost	49,857	82.67%	
Contingency and taxes	10,473	17.37%	
Estimated total project cost	**60,330**		

4.2.Appropriateness of the Project Cost Calculation

[Table Ⅷ-9] Appropriateness of the Project Cost Calculation

Project	Detailed item	Remarks
Construction of Land and Spatial Information DB	Itemized unit cost calculation method	Calculation of the unit cost of each unit process (calculation based on manpower input and days of work per unit process)
	Direct labor costs	Calculating direct labor costs of survey engineers Direct labor costs = Work hours per survey engineer grade × Unit price for labor per class per month
	Labor unit price	Application of labor cost by survey engineer grade (Korea Association of Spatial Information Surveying and Mapping)
	Expense & Fee	Expense: Compliance with Korea Export-Import Bank Guidelines (110% of direct labor cost) Fee : Compliance with Korea Export-Import Bank Guidelines (40% of direct labor cost)
	Direct cost	Calculation as local business trip expenses according to the number of workers and total working days for each process (international airfares, visa fees, expenses during stay, vehicle rental fees, interpreter fees)
System (LAS & LISS) construction	Direct labor costs	Calculation of direct labor costs for the manpower used for software development Direct labor costs = Work hours per developer class × Unit price for labor per class per month
	Unit price for labor (base rate)	The unit price for labor by technician class that was applied was taken from the 2018 Base Rate for Software Technician issued by the Korea Software Industry Association (KOSA).
	Overhead expenses & engineering fee	Calculate the overhead expenses and engineering fees for software developers Calculation of expenses = Direct labor costs × 110% Calculation of charges = Direct labor costs × 40%
Data center and infrastructure construction	Purchase	The system performance and capacity calculation was based on A Guideline for Hardware Sizing of Information Systems issued by the Telecommunications Technology Association (TTA) of Korea and the monthly price data (Korea Price Research Center),[37] manufacturer quotations and market prices were examined to obtain the basis for the calculation
	Labor costs	Direct labor costs: Calculated based on the average wages of Korean software technicians and the results of a wages survey on engineering firms (2018) in combination with the labor costs calculated based on the actual man hours Indirect labor costs: Calculated based on the Korea Export-Import Bank guidelines by applying the formula “110% of the direct labor costs = overhead expenses” and “40% of the direct labor costs =

37 Korea Price Research Center (KPRC, 2018

Project	Detailed item	Remarks
		engineering fees”
	Travel expenses	The travel expenses incurred from dispatching engineers from Korea to Sri Lanka were calculated based on the travel expenses regulations[38] for Korean public servants while taking into account to realistic costs
	Installation and transportation	Calculated based on marine transportation
	IDC rental	Since it occupies some of the space in the National Data Center (NDC) operated by Sri Lanka Telecom (SLT), it was calculated based on the space usage fees (table) associated with the amount of power provided by SLT (16A dual 4 units, 32A dual 2 units) and the cost was calculated as the amount to be borne by GoSL

4.3.Appropriateness of the Project Costs by Field

4.3.1.Land and Spatial Information DB Area

- The costs that make up the area of database construction are the costs of computerization o f the old survey plans, the construction of a spatial DB for the 24 major MCs, 50cm satelli te orthoimage production, additional installation of CORS Network (32 locations), and provi sion of computer equipment for survey and database construction.

- The costs that The computerization cost of old survey plans is calculated based on the follo wing steps: inspection of the scanned drawings; rescanning of the poorly scanned drawings; reference point extraction and ground coordinate input for geo-referencing; geometry check for geo-referencing; inspection of geo-referencing results; adjacency adjustments; digitizing work for extracting spatial data for each parcel from geo-referenced drawings; inspection of digitizing results; and the construction of spatial DB.

- In the case of computerization of old survey plans, the project cost for each step was calcul ated according to the work process. Local technicians are to be deployed in each stage to p erform most of the processes, while Korean technicians are to perform inspection and adjust ment for major processes and to produce the final outputs. Therefore, the areas in which th e local technicians would be used were reviewed in depth.

- As for the labor costs related to Korean technicians, the 2018 Base Rate for Surveying Tec hnician (Korean Association of Spatial information, surveying & Mapping, KASM) was app lied, and the market price of a local survey company was applied for the calculation of the labor costs of local technicians.

38 2016, Payment of Overseas Travel Expenses for Korean Public Servants

- The cost of constructing a spatial database for 24 MCs was calculated based on the following steps: UAV survey consisting of five groups based on the UAV survey plan for the 24 MCs; digitizing parcels (incl. buildings and streets) used for UAV survey results; on-site complementary survey for not-confirmed points; Create and editing of the digitizing results and on-site complementary survey results; Investigation and inputting attribute data; and spatial database construction and inspection.

- The cost for each process of UAV orthoimage production by UAV survey was calculated based on the itemized unit cost per 10km^2 for five processes: work planning and preparation; ground control point selection and survey; UAV flight and sensor data acquisition; UAV data processing; and final results production.

- In the case of UAV survey, in addition to local capacity building training, the project cost is calculated so that local technicians can be assigned to the UAV flight and sensor data acquisition process as well as ground control point survey and data processing processes so that they may acquire the related skills.

- As for the digitizing process which involves extracting the boundary of each parcel (incl. buildings and streets) from aerial orthoimages obtained by UAV survey, the cost was determined so that the work would be done by local technicians. The quantity of the boundary points that cannot be identified on UAV aerial orthoimages due to obstacles was assumed to be 20% of the total quantity (based on the results of the 2017 LX’s self-ordered project) to calculate the quantity for the on-site complementary survey.

- The cost of the on-site complementary survey was calculated so that it would be carried out by a survey team (1 advanced technician and 2 intermediate technicians) comprised of local survey technicians. The cost of editing the final spatial data by combining the survey results with the digitized boundary was also calculated under the assumption that it would be performed by local technicians.

- Furthermore, the cost of investigation and inputting attribute data in relation to spatial data was also calculated based on the employment of local technicians, where the cost for process of inspecting the spatial data and attribute data and joining them through structured editing was calculated by considering that it would be performed by Korean technicians in order to produce the final outputs.

- The cost of 50cm satellite orthoimage production was calculated based on the following steps: procurement of KOMPSAT-3/3A satellite images; procurement of 1m-grid-interval DEM for ortho rectification; ground control point survey for orthoimage production; data processing; and tiling of the results.

- New satellite imaging and supply of the entire Sri Lanka should be completed within a short time, and repeated shooting should be made in consideration of the characteristics of the marine climate.

- Considering this particularity, commercial satellites cannot apply the amount of clouds inclu ded in satellite images as a constraint, and simply set a supply price as a cost for one shot. Therefore, there are risks in terms of time and cost in acquiring new images of less than 1 0% of cloud volume through commercial satellites of third countries. (Considering climatic characteristics, it is difficult to calculate the project cost clearly because the cost of acquirin g new images varies depending on the number of shots.)

- However, Korea's KOMPSAT-3/3A satellite guarantees new images with less than 10% clo ud cover over the whole of Sri Lanka, and it is possible to acquire new satellite images thr ough repeated shooting based on national official power.

- DEM with 1m grid spacing utilizes data from Intermap's NextOne, the only commercially a vailable DEM and DTM for the world. This is based on the Interferometric Synthetic Apert ure Radar (IFSAT) and ICESAT data obtained in Sri Lanka. (This is a requirement of the p roject organization.)

- Leverages commercial DEMs that supply the world's only DEM with 1m grid spacing, and combines some DEM data (Lidar data for some regions) possessed by the Survey Departme nt of Sri Lanka as a DEM for orthoimage production.

- The KOMPSAT-3/3A satellite images of the entire territory of Sri Lanka are composed of 96 scenes based on the satellite shooting cycle and satellite orbit prediction. As for the grou nd control point survey for ortho rectification of the satellite images, there are 6 control poi nts for each scene for a total of 570 control points, based on which the project cost was ca lculated, while also taking into consideration that the work would be performed by both Ko rean and local technicians

- The cost of satellite image data processing and the tiling process were calculated under the assumption that they would be carried out by Korean engineers working in Korea.

- The cost of additional installation of CORS Network (32 locations) was calculated based on the following processes: procurement of CORS equipment; checking local installation locati on; inspecting local equipment; on-site installation of CORS; and test operation and inspecti on

- The cost of purchasing CORS equipment includes the cost of installing CORS in Sri Lanka (incl. labor and material costs), five years of maintenance and repair, and one training sess ion. The project cost was calculated so that there would be two Korean technicians dispatch ed to Sri Lanka to check the installation location for 30 days; two Korean technicians to in spect the local equipment for 15 days; and two Korean technicians to partake in the test op eration incl. network adjustment for 30 days.

- The cost for construction of land and spatial information DB was subdivided into each cons truction process so as to effectively respond to the fluctuation risk resulting from an increas e/decrease in quantity.

- In addition, 60.208% of the cost of database construction was allocated to the labor costs f or Sri Lankan technicians. Thus, it is deemed to have an appropriate project cost compositi on that reflects localization of construction technology for land and spatial information DB.

4.3.2. System Construction

- As for the schedule designated for system development, the first 4 months is to be spent on analysis and design and 20 months on system development, after which 6 months is spent on integration testing and 6 months on test operation prior to delivery of the final system.
- 80% of the system development work will take place in Korea. Business trip to Sri Lanka i s necessary in the analysis and design phase, whereas development work will be mainly per formed in Korea in order to reduce expenses. When it comes to system development, “wher e” it is developed does not have any negative consequences.
- About 20% of the development work will be undertaken by local developers in Sri Lanka. The competency to maintain and repair the system should be developed in the private secto r in the future.
- For the first month after the start of the project, a total of 16 workers for system developm ent will be dispatched to Sri Lanka to analyze the requirements and the related tasks.
- During the system development period, 10 workers for system development, on average, wil l be dispatched to Sri Lanka over the course of five trips to share the development results a nd reflect the requirements in system development.
- After the system is developed and unit testing is finished, 5 people will be dispatched to Sr i Lanka for 6 months to perform integration testing, improve testing, and eliminate defects.
- For 6 months after the integration test, a Korean technician will test operate the system for stabilization purposes and proceed with technology transfer through user and operator traini ng.
- The cost estimation method based on the function point is calculated based on the function regardless of the technical level of the domestic developer and the local developer in the re cipient country and can provide rare proof to apply benefit for Domestic developer and the local developer. S / W is not suitable for measurement, and the project cost for system con struction of this project is calculated by the manpower calculation
- As a result of comparing the cost of manpower input and the function point method, the co st of manpower input method is similar to the 95% of the function point method cost

4.3.3. Data Center and Infrastructure Construction

- The construction of the data center and infrastructure begins with the improvement work on the network and operating facilities of the local offices for about 3 months starting in the second half of the second year of the construction phase, taking into consideration the datab ase acquisition and digitization schedule, the LIS service development schedule, and the ma nufacturer’s warranty period. Computation system will be set up at one backup data center and one main data center over the course of 6 months.

- For the environmental improvement work for the local offices, which is expected to take 3 months, the cost was calculated based on two workers, on average, working to make switch from a wireless environment found to have low efficiency to a wired private network and to create an environment in which the government network named LGN 2.0 can be univers ally used at the district and divisional survey offices in 9 provinces.

- The establishment of a backup data center will occur first in order to promote the transition from the existing system, and this will take 1.5 months. It will include functional tests util izing the infrastructure required for building the system in a short period of time by utilizin g the existing facilities of IDC.

- The cost incurred during the period of establishing and stabilizing the LIS services after sett ing up the computer facilities at the backup datacenter was calculated. The environmental s etup for the main data center, which can proceed during the establishment and stabilization the LIS services, can allow for efficient management of human resources.

- After the completion of the setup, experts from each field will be dispatched to perform an integration test on the equipment that has been set up for a period of about 5 months (2 m onths, 1 month, 2 months).

- The cost categories for data center construction are divided into server and storage, backup, network and security equipment, interior, and infrastructure. The cost of each field was det ermined by requesting a Korean company to provide a quote that included labor costs. Cros s-validation was performed to determine the appropriateness of the cost. A 3-year cost was calculated by adding together the costs incurred from one year of data center construction a nd two years of maintenance and repair.

- The labor costs and travel expenses for Korean technicians were calculated based on the av erage wages of Korean software technicians (2018), the results of a wages survey on engine ering firms (2018) and the monthly average unit price for labor found in the KEXIM guidel ines.

- The cost of renting the space for the backup data center was applied based on the rates pro vided by SLT, a national telecommunications company. The 2 years' worth of rent was to be borne by the recipient country.

- Transportation costs, installation and test costs are included on estimation cost for ICT equi pments (materials), and it has been analyzed and compared the quotation from multiple man ufacturer/product and market, in order to secure the appropriate price.

- The aim of this project is to establish the Sri Lanka Land Information System (LIS) for mo dernizing land management in Sri Lanka.

- The main objective of this project is to strengthen the land administration capacity of the g overnment of Sri Lanka and to improve the quality of public land administration services. F urthermore, it is aimed at enhancing transparency and equity in relation to land managemen t and boost land-related tax revenue.

- The goal of this project is not to generate profits, and it will be executed based on the gov ernment budget. It is, therefore, unnecessary to analyze financial feasibility.

5.Economic Feasibility Analysis

5.1.Overview and Assumptions

- In this chapter, the economic feasibility analysis of the project in question will be performe d using the benefit-cost analysis. For this purpose, the total benefits and total costs of the p roject were estimated, and the economic feasibility was analyzed based on the net present v alue (NPV), benefit/cost ratio (B/C ratio), and internal rate of return (EIRR).

- The NPV is the most widely used measure for an economic feasibility analysis. The NPV o f a project is defined as the difference between the sum of the present value of the total ca sh inflows and the present value of the total cash outflows. If the NPV is greater than zero, the project is considered economically feasible.

- The B/C ratio is complementary to the NPV because the NPV is affected by the scale of in vestment in the project. If the B/C ratio is greater than 1, the business is considered econo mically feasible.

- The EIRR or internal return rate (IRR) is the discount rate that makes the present value of the total cash inflows become equal to the present value of the total cash outflows. As a ba sis for determining economic feasibility, the EIRR of the project must be greater than the s ocial discount rate.

5.1.1.Discount Rate and Inflation Rate

- Based on the Economic Feasibility Analysis Criteria for EDCF Projects, a 9% discount rate was applied in this economic feasibility analysis.

- The USD-LKR exchange rate used in this feasibility analysis was 175.43 LKR per dollar (1 5-day average sell rate from June 28, 2019 to July 12, 2019), and the USD-KRW exchange rate that was applied was 1,172.55 KRW per dollar.

- In this feasibility study, the inflation rate that was applied was 4.95%, and this was the ave rage inflation rate (unit: percentage change) in Sri Lanka from 2016 to 2018, determined by the IMF.

[Table Ⅷ-10] Inflation Rate in Sri Lanka

(Unit: %)

Country	2016	2017	2018	Average
Sri Lanka	3.99%	6.58%	4.27%	4.95%

Source: IMF website (2019)

5.1.2.Analysis Period

- ❍ The project is expected to take a total of 51 months from the date on which the loan agreement becomes effective (assumed as January 2020 to March 2024).

- ❍ The benefit-cost analysis period for information systems project is typically 5~15 years after the system is implemented. In reference to a similar project, In reference to a similar project, it was assumed that the benefits of the information system built would last for 10 years. Therefore, the total analysis period was 15 years, comprised of 5 years of project execution and 10 years of usage period.

- ❍ The base year for economic feasibility analysis was assumed to be 2020.

[Table Ⅷ-11] Estimated Project Costs

(Unit: 1,000 USD)

Item	EDCF				GOSL	Total
	Foreign Currency Portion		Local Currency Portion	EDCF Total		
	Korea	3rd Countries				
1. Construction of land and spatial information DB	5,267	5,192	15,804	26,263	0	26,263
2. Development of Land Information System	7,272	81	1,187	8,540	0	8,540
3. Data Center & Infrastructure	2,011	4,087	106	6,204	166	6,370
4. Capacity Building	897	274	469	1,640	307	1,947
5. Consulting Service	3,864	0	506	4,370	0	4,370
6. Operation and Maintenance Support	1,405	78	204	1,687	0	1,687
7. PMU	0	0	0	0	680	680
Direct Cost	20,716	9,712	18,276	48,704	1,153	49,857
8. Tax and Duties	0	0	0	0	4,285	4,285
9. Contingencies	1,683	1,292	3,159	6,134	0	6,134
10. EDCF Service Charge	54	0	0	54	0	54
Total	22,453	11,004	21,435	54,892	5,438	60,330
Percentage (%) of EDCF	40.90%	20.05%	39.05%	100.00%		
Percentage (%) of Total	37.22%	18.24%	35.53%	90.99%	9.01%	100.00%

* All taxes, duties, and levies imposed on goods and services in the democratic socialist republic of Sri Lanka provided by the Suppliers will be exempted by the Government of Sri Lanka.

5.2. Cost Estimation

5.2.1.Project Cost

- ❍ The total cost of this project was estimated at USD 60,330,000. The detailed breakdown of the project cost estimates and the annual project costs are shown in the following tables:

[Table Ⅷ-12] Project Costs by Year

(Unit: 1,000 USD)

Item	Y1	Y2	Y3	Y4	Y5	Total
Annual Project Cost	2,304	22,724	24,547	8,703	2,049	60,330
Percentage (%) of Total	3.82%	37.67%	40.69%	14.43%	3.40%	100.00%

5.2.2.Operating Costs

❍ Operating costs were estimated by categorizing them into (1) labor costs, (2) maintenance c osts, (3) IDC rental costs, and (4) electricity charges.

1) Labor costs

❍ The necessary manpower and labor costs are as follows:

[Table Ⅷ-13] Operating Personnel and Wages

Workforce classification	Role	Number of personnel	Annual salary per person (Unit: LKR)	Annual salary per person (Unit: USD)	Total salary (Unit: USD)
Training	SW Expert	1	2,400,000	13,681	13,681
	ICT Expert	1	474,000	2,702	2,702
SW Maintenance	Junior SW Developer	2	482,280	2,749	5,498
	Intermediate SW Developer	2	608,040	3,466	6,932
	Senior SW Developer	2	1,044,660	5,955	11,910
Data Center	Senior HW Expert	2	3,000,000	17,101	34,202
	Junior HW Expert	2	2,400,000	13,681	27,361
	Senior NW Expert	1	3,000,000	17,101	17,101
	Junior NW Expert	11	2,400,000	13,681	150,487
Total					269,874

2) Maintenance Costs

❍ Maintenance costs are further divided into (1) software maintenance costs and (2) ICT infra structure maintenance costs for cost estimation purposes.

❍ The maintenance rate for an information system is usually 10~15%[39] of investment cost, an d in this economic feasibility analysis, 12% was applied considering the level of difficulty i n maintaining the system.

39 Korea Software Industry Association, Guide on Calculating Software Project Costs, 201

❍ The specific maintenance costs are shown in the following table:

[Table Ⅷ-14] Maintenance Costs

Item	Project cost (Unit: USD)	Maintenance rate	Annual maintenance cost standard (Unit: USD)
SW	8,540,000	12.00%	1,024,800
ICT Infrastructure	6,370,000	12.00%	764,400
Total			1,789,200

3) IDC Rental Costs

❍ IDC rental costs were estimated based on local IDC rental costs as follows:

[Table Ⅷ-15] IDC Rental Costs

System specification	Number of racks	Annual rental cost per rack (Unit: USD)	Annual rental cost (Unit: USD)
16A × 2	4	11,628	46,512
32A × 2	2	18,468	36,936
Total			83,448

4) Electricity Charges

❍ The annual electricity charges were estimated based on the local electricity charges: (1) main data center electricity charges, (2) district survey offices' electricity charges, and (3) divisional survey offices' electricity charges.

❍ The estimated annual electricity charges are as follows:

[Table Ⅷ-16] Electricity Charges

Item	Annual electricity cost per site (Unit: USD)	Number of sites	Annual electricity cost (Unit: USD)
Main data center	17,931	1	17,931
District survey office	706	25	17,642
Divisional survey office	124	84	10,426
Total			46,000

5.3.Benefit Estimation

❍ This project includes both measurable benefits and those that are difficult to convert into monetary value.

❍ For example, this project affords transparency and efficiency in land management in Sri Lanka, thereby ultimately contributing to Sri Lanka's socioeconomic growth engines; however, this is not easy to measure quantitatively.

❍ Thus, the following benefits that can be converted into monetary value as follows were included in the benefit analysis in this economic feasibility analysis:

– Faster access to land information for citizens

– Reduced transportation costs for citizens trying to access to land information
– Increased productivity of public servants performing land management
– Land tax income increase

5.3.1.Faster Access to Land Information for Citizens

❍ Currently, citizens need to personally visit the office concerned to access land information, but they will be able to access the information online through the land information system established through this project. This will save time as there is no need to make a personal visit.

❍ The formula for estimating this benefit is as follows:

Annual benefit from faster access to land information for citizens (n) = Number of times land registration documents are accessed a year (n) × Estimated amount of time saved by the applicant in each case × Value of the time saved by the applicant × (1+inflation rate)^n, n = 1, ..., 10

❍ The main assumptions for estimating this benefit are as follows:

❍ The number of times land registration documents are accessed a year was estimated to be “365,000 per year.”

❍ The estimated amount of time saved by the applicant in each was estimated to be “2 days,” including visit time and waiting time.

❍ The value of the time saved by the applicant was calculated by first taking Sri Lanka’s minimu m wage per day (USD 2.85) and reflecting the economic activity rate (EAR, labor force particip ation rate, LFPR) of Sri Lanka which is 54.10% to come up with a rate of “USD 1.54 per da y.”

[Table Ⅷ-17] Benefit: Faster Access to Land Information for Citizens

Item	Annual number of access	Time saving (Unit: Day)	Transport cost saving (Unit: USD)
Title access	65,000	2	

5.3.2.Reduced Transportation Costs for Citizens Accessing Land Information

❍ Not only will citizens enjoy faster access to land information, but also save on transportatio n costs.

❍ The transportation cost per case for accessing the land registration document was estimated as shown in the table above, and the formula for estimating this benefit is as follows:

Annual benefit from reduced transportation cost for citizens accessing land information (n) = Number of times land registration documents are accessed a year (n) × Estimated amount of money saved (lower transportation cost) by the applicant in each case × $(1+\text{inflation rate})^n$, n = 1, ..., 10

5.3.3. Increased Productivity of Public Servants Performing Land Management

- The system established through this project can help improve the work productivity of publi c servants handling land information.
- More specifically, the tasks where productivity is expected to improve are shown in the foll owing table:

[Table Ⅷ-18] Improved Productivity in Land Management

Item	Annual number of transactions	Time saving per person
Field surveying (preparations~execution)	600	- Preparations: 3 days - Surveying: 1 day or longer - Office work: 1 day or longer
Title registration (Bim Saviya)	365,000	- 3 days or longer
Land data transfer (SDSL->Land Settlement Department)	60,000	- 5 days or longer
Subdivision application (local authority)	5,000	- 1 day or longer
Land information modification (Title)	182,500	- 1 day or longer

- The formula for estimating this benefit is as follows:

Annual benefit from increased productivity of public servants performing land management (n) = Number of land management cases handled a year (n)× Reduced time per case × Value of the time saved by the public servant × benefit reflection rate $\times(1+\text{inflation rate})^n$,

- The additional assumptions for estimating this benefit are as follows:
- The value of the time saved by the public servant performing land management official was

estimated to be USD 2.71. This was the value per hour determined based on estimated annual salary of USD 5,200 for public servants in charge of land management.

- Instead of reflecting the reduced processing time expected as a benefit, 5% of the reduced processing time was reflected in order to estimate the benefits conservatively.

5.3.4.Land Tax Income Increase

- The system established through this project can contribute to increase land tax income by providing accurate land information.
- The formula for estimating this benefit is as follows:

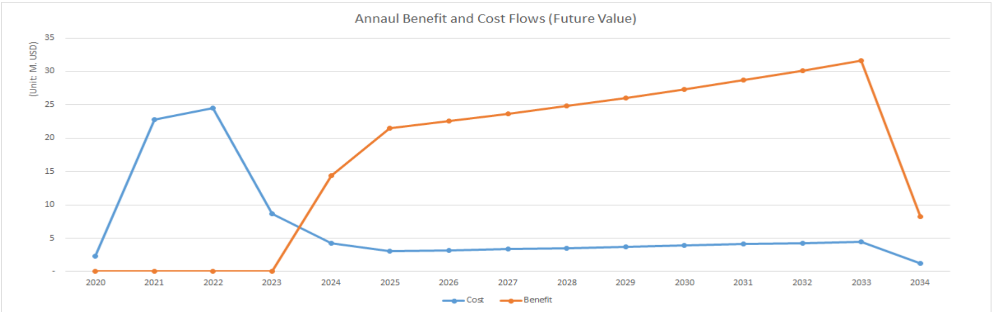
Annual land tax income increase (n) = Base annual land tax income × Tax increase rate due to the project ×(1+inflation rate)^n, n = 1, ……, 10

- The main assumptions for estimating this benefit are as follows:
- Based on tax income statistics for 2017 and 2018, base annual land tax income is estimated at USD 22,665,680.
- The increase rate due to the project is estimated at 4.6% based on the opinions of local experts.
- The annual land tax income is estimated by reflecting the inflation rate.

5.4.Benefit-Cost Analysis

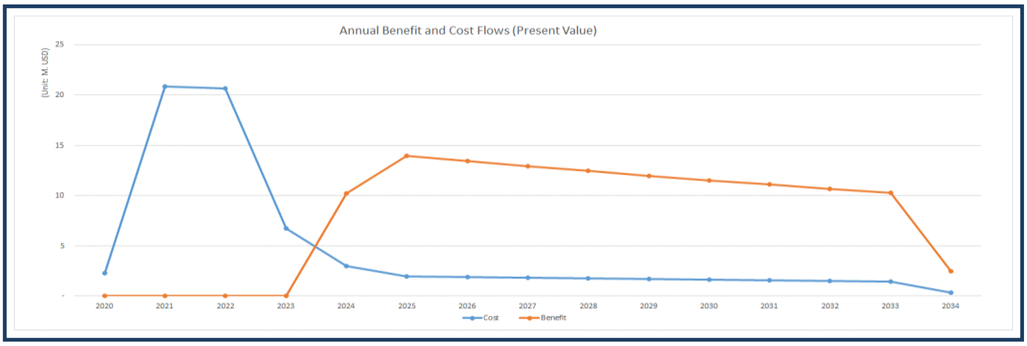
5.4.1.Cost and Benefit Flow

- The following figure shows the cash flows of annual costs and benefits in terms of future value



[Figure Ⅷ-1] Annual Cost and Benefit Flow (Future Value)

The following figure shows the cash flows of annual costs and benefits based on the present value. The discount rate applied was 9%, the social discount rate.



[Figure Ⅷ-2] Annual Cost and Benefit Flow (Future Value)

❍ The following table shows the details of the cash flows of annual costs and benefits.

[Table Ⅷ−19] Benefit-Cost Analysis Result

(Unit: 1,000 USD)

Year	Cost				Benefits					
	Cost* (future)	Operation (future)	Total future value	Total present value	Access time benefits for public (future)	Access traffic benefits (future)	Increase of work efficiency (future)	Increase of land related tax (future)	Total future value	Total present value
2020	2,304	0	2,304	2,304	0	0	0	0	0	0
2021	22,727	0	22,727	20,850	0	0	0	0	0	0
2022	24,547	0	24,547	20,661	0	0	0	0	0	0
2023	8,703	0	8,703	6,720	0	0	0	0	0	0
2024	2,049	2,193	4,242	3,005	1,024	871	12,501	949	14,396	10,198
2025	0	3,068	3,068	1,994	1,433	1,218	17,493	1,327	21,471	13,955
2026	0	3,220	3,220	1,920	1,504	1,279	18,358	1,393	22,533	13,436
2027	0	3,380	3,380	1,849	1,578	1,342	19,266	1,462	23,648	12,936
2028	0	3,547	3,547	1,780	1,656	1,408	20,219	1,534	24,818	12,455
2029	0	3,722	3,722	1,714	1,738	1,478	21,219	1,610	26,045	11,992
2030	0	3,906	3,906	1,650	1,824	1,551	22,269	1,690	27,333	11,546
2031	0	4,099	4,099	1,589	1,914	1,628	23,370	1,773	28,685	11,117
2032	0	4,302	4,302	1,530	2,009	1,708	24,526	1,861	30,104	10,703
2033	0	4,515	4,515	1,473	2,108	1,793	25,739	1,953	31,593	10,305
2034	0	1,185	1,185	354	553	470	6,753	488	8,265	2,473
Total	60,330	37,137	97,467	69,393	17,343	14,746	211,712	16,040	258,892	121,116

* To calculate present values, the discount rate applied is 9%

5.4.2.Benefit-Cost Analysis Method

❍ NPV, B/C ratio, and EIRR are three most commonly used measures for benefit-cost analysis of a project.

1) Net Present Value (NPV)

- NPV is the sum of the present value of benefits and costs for a certain amount of time.
- NPV is calculated as follows:

$$NPV = \sum_{t=0}^{n} \frac{B_t}{(1+r)^t} - \sum_{t=0}^{n} \frac{C_t}{(1+r)^t}$$

where B_t = benefit in year t

C_t = cost in year t

r = social discount rate

n = economic analysis period

- NPV can be used to compare alternatives. Of the project options, the one with the highest NPV is selected.
- However, in order for a project to be absolutely feasible, its NPV must be greater than zero

2) Benefit/Cost Ratio (B/C Ratio)

- The B/C ratio is defined as the total present value of the benefits divided by the total prese nt value of the costs.
- The formula for calculating the B/C ratio is as follows:

$$B/C\ ratio = \sum_{t=0}^{n} \frac{B_t}{(1+r)^t} / \sum_{t=0}^{n} \frac{C_t}{(1+r)^t}$$

- In order for a project to be economically feasible, its B/C ratio must be greater than 1.

3) Economic Internal Rate of Return (EIRR)

- EIRR is a discount rate that makes the total present value of benefits and the total present value of costs become equal.
- EIRR is an R value satisfying is the R value that satisfies the following formula:

$$\sum_{t=0}^{n} \frac{B_t}{(1+R)^t} = \sum_{t=0}^{n} \frac{C_t}{(1+R)^t}$$

- For a project to be economically feasible, its EIRR must be greater than the social discount rate.

5.4.3.Benefit-Cost Analysis Results

- This project Benefit-Cost analysis results are shown in the following table:

[Table Ⅷ-20] Future Values and Present Values of Cost and Benefit

Cost		benefits	
Future value	Current value	Future value	Current value
97,467,457 USD	69,392,905 USD	258,891,638 USD	121,115,894 USD

- The NPV, B/C ratio and EIRR for this project are shown in the following table:

[Table Ⅷ-21] Benefit-Cost Analysis Results

NPV	B/C ratio	EIRR
51,722,988 USD	1.75	21.50%

- Since the NPV is greater than zero, the B/C ratio is greater than 1.0, and the EIRR is great er than the social discount rate (9%), the project is economically feasible.

5.5.Sensitivity Analysis

5.5.1.Sensitivity Analysis According to Changes in Discount Rate

- The discount rate in this economic feasibility analysis is assumed to be 9% based on the E conomic Feasibility Analysis Criteria for EDCF Projects.

- When the discount rate changes from 6.0% to 12.0%, the changes in the NPV and B/C rati os are as follows:

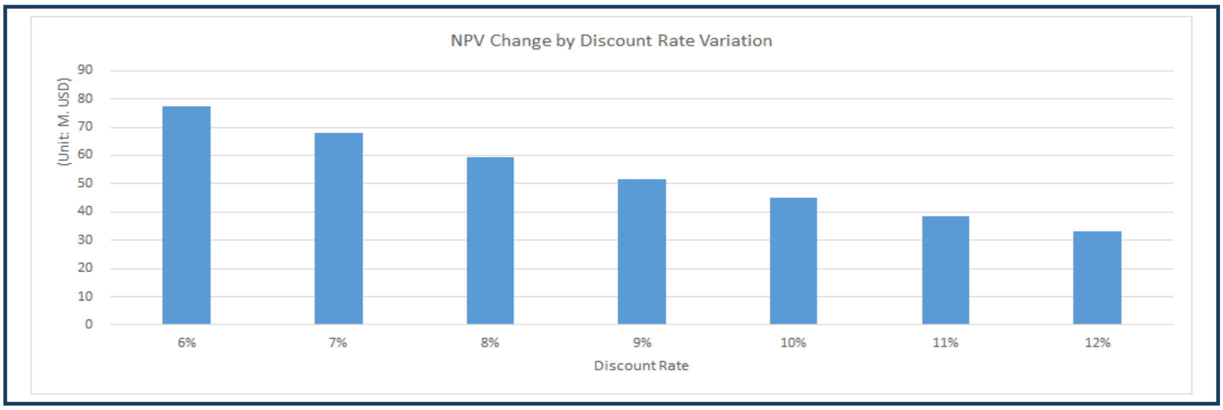
[Table Ⅷ--22] Sensitivity Analysis in Relation to Discount Rate

Discount rate	NPV	B/C ratio
6%	77,231,757	2.01
7%	67,820,181	1.92
8%	59,351,747	1.83

Discount rate	NPV	B/C ratio
9%	51,722,988	1.75
10%	44,842,902	1.67
11%	38,631,319	1.59
12%	33,017,508	1.52

❍ In the above table, the 12% discount rate results in the worst economic feasibility. Even in this case, however, the NPV is greater than 0 and the B/C ratio is greater than one. Theref ore, even in the worst case scenario, the project has economic feasibility.

❍ The figure below shows the changes of NPV according to the changes of discount rate.



[Figure Ⅷ-3] NPV Changes According to Discount Rate Changes

5.5.2.Sensitivity Analysis According to Benefit and Cost Changes

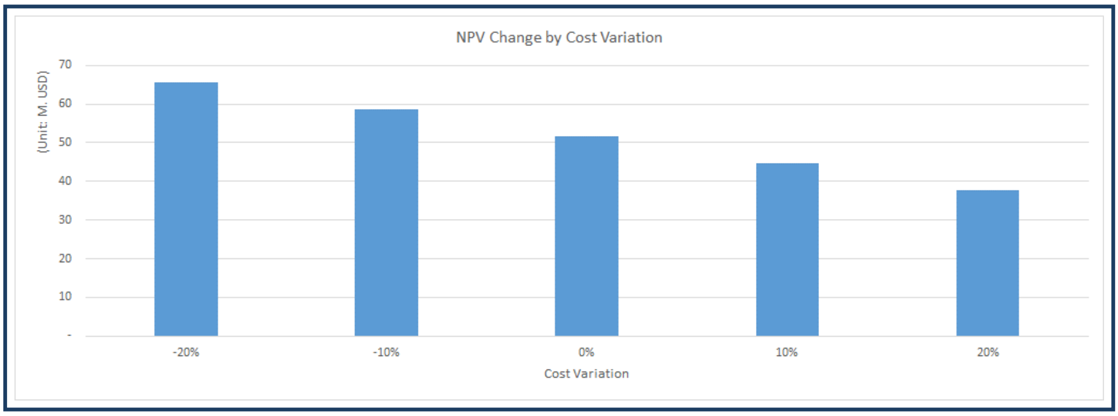
❍ The table below shows the results of sensitivity analysis when the cost is assumed to vary f rom -20% to + 20%.

[Table Ⅷ-23] Sensitivity Analysis in Relation to Cost

Cost change	NPV	B/C ratio	EIRR
-20%	65,601,569	2.18	26.96%
-10%	58,662,279	1.94	24.04%
0%	51,722,988	1.75	21.50%
10%	44,783,698	1.59	19.26%
+20%	37,844,407	1.45	17.26%

❍ In this table, the worst economic case is when the cost increase 20%. However, even in thi s case, the NPV is greater than 0, B/C ratio is greater than 1, and EIRR is greater than soc ial discount rate. Therefore, even in the worst case scenario, the project has economic feasi bility.

❍ The following figure shows the changes in the NPV according to the changes in the cost.



[Figure Ⅷ-4] NPV Changes According to Cost Changes

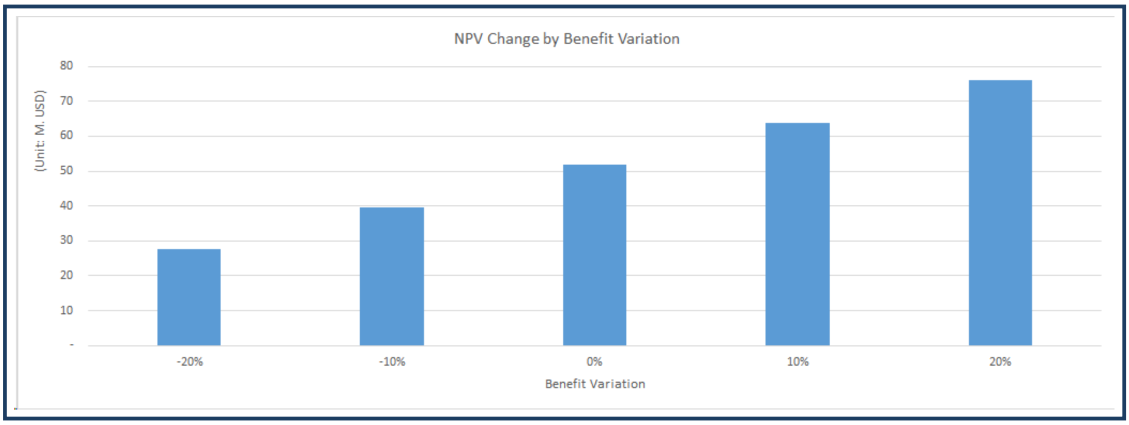
❍ The table below shows the results of the sensitivity analysis when the benefits vary from -20% to + 20%.

❍ The worst case in this table is a 20% decline in benefits. Even in this case though, the NPV is greater than 0, the B/C ratio is greater than 1, and EIRR is greater than social discount rate. Therefore, even in the worst case, the project has economic feasibility.

[Table Ⅷ-24] Sensitivity Analysis in Relation to Benefits

Benefit change	NPV	B/C ratio	EIRR
-20%	27,499,810	1.40	16.33%
-10%	39,611,399	1.57	19.03%
0%	51,722,988	1.75	21.50%
10%	63,834,578	1.92	23.79%
+20%	75,946,167	2.09	25.94%

❍ The figure below shows the changes in the NPV according to the changes in the benefits.



[Figure Ⅷ-5] NPV Changes According to Benefit Changes

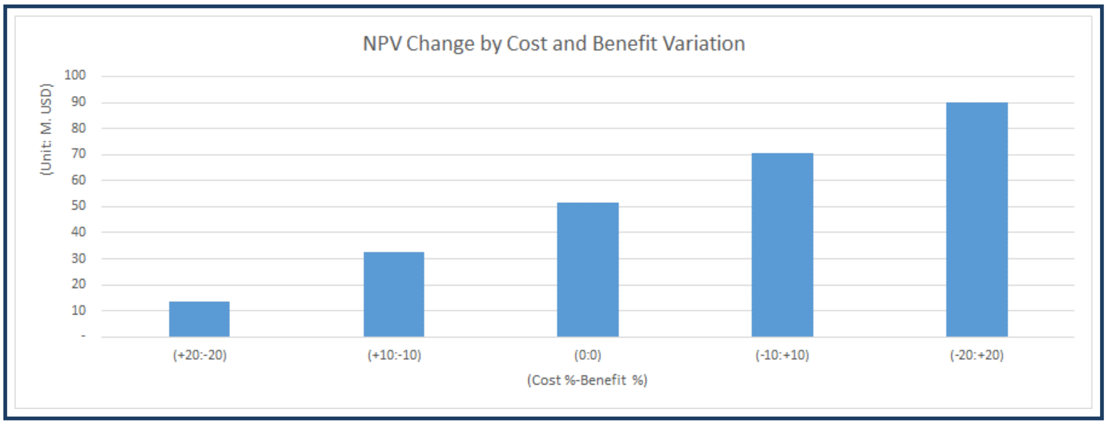
❍ The table below shows the results of the sensitivity analysis when costs and benefits change simultaneously.

❍ In this table, the worst case is a 20% increase in costs and 20% decrease in benefits, but even t hen, the NPV is greater than 0, the B/C ratio is greater than 1, and EIRR is greater than social discount rate. Therefore, even in the worst case scenario, the project has economic feasibility

❍ The figure below shows the changes in NPV when the cost and benefit change simultaneou sly.

[Table Ⅷ-25] Sensitivity Analysis When Benefits and Costs Change Simultaneously

Cost change: Benefit change	NPV	B/C ratio	EIRR
(+20% : -20%)	13,621,229	1.16	12.28%
(+10% : -10%)	32,672,109	1.43	16.84%
(0% : 0%)	51,722,988	1.75	21.50%
(-10% : +10%)	70,773,868	2.13	26.40%
(-20% : +20%)	89,824,748	2.62	31.70%



[Figure Ⅷ-6] NPV Changes According to Cost and Benefit Changes

5.6.Summary of Economic Feasibility Analysis

❍ An economic feasibility analysis of the Sri Lanka LIS project was carried out based on the benefit-cost analysis method.

❍ The economic feasibility of the project was analyzed centering on social benefits and costs using the net present value (NPV), benefit/cost ratio (B/C ratio), and economic internal rate of return (EIRR) and a sensitivity analysis was carried out.

❍ The analysis period was set to be 15 years, which included 51 months as the project imple mentation period and 10 years as the land information system operating period.

❍ The total project cost was estimated at USD 60,330,000, of which EDCF fund was estimate d to be USD 54,892,000 (90.99%) and Sri Lankan government's fund USD 5,438,000 (9.0 1%).

❍ Operating costs were estimated by categorizing them into labor costs, maintenance costs, ID

C rental costs, and electricity charges.

- ❍ Benefits were estimated by categorizing them into the following: (1) Faster access to land information for citizens; (2) Reduced transportation costs for citizens trying to access to land information; (3) Increased productivity of public servants performing land management; and (4) land tax income increase.

- ❍ The NPV, B/C ratio and EIRR obtained through the benefit-cost analysis are as follows:

[Table Ⅷ-26] Summary of Benefit-Cost Analysis Results

NPV	B/C ratio	EIRR
51,722,988 USD	1.75	21.50%

- ❍ The NPV is USD 51,722,988 and thus greater than 0; the B/C ratio is 1.75, which is greater than 1.0; and EIRR is 21.50%, which is greater than the social discount rate of 9%. Therefore, this project has economic feasibility.

- Sensitivity analysis with respect to the changes in discount rate, cost, and benefits was also performed. It was found that even when the discount rate changes from 6% to 12%, the project is still economically feasible based on the resulting NPV, B/C ratio, and EIRR.

- The project has economic feasibility even if the costs increase by 20% or the benefits decrease by 20%.

- Plus, the NPV, B/C ratio, and EIRR show that the project is economically feasible, even in the worst case scenario where the costs increase by 20% and benefits decrease by 20% at the same time. In conclusion, this project has economic feasibility.

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