Municipal
Spatial Data
Infrastructure

MSDI Manual
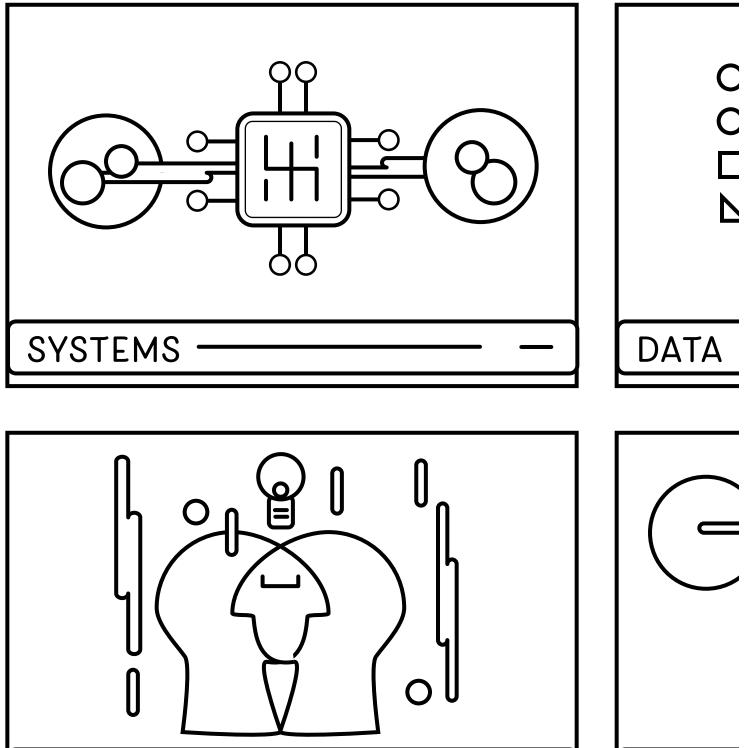
PEOPLE

SYSTEMS

DATA

INSTITUTIONS

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SYSTEMS ————————————————— —

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INSTIT

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LIST OF
ABBREVIATIONS

ANZLIC — Australia New Zealand Land Information Council

API — Application Program Interface

ATR/BPN — *Kementrian Agraria dan Tata Ruang/ Badan Pertanahan Nasional* / Ministry of Agrarian and Spatial Planning of Indonesia / National Land Agency

BAPPEDA — *Badan Perencanaan Pembangunan Daerah* / Indonesia Local Development Planning Agency

BAPPENAS — *Badan Perencanaan Pembangunan Nasional* / Indonesia National Development Planning Agency

BIG — *Badan Informasi Geospacial* / Indonesia Geospatial Information Agency

CIP — Capital Investment Planning

CPL — City Planning Labs

DISKOMINFO — *Dinas Komunikasi dan Informatika* / Indonesia Municipal Informatics and Communication Agency

DISTARU — *Dinas Penataan Ruang* / Indonesia Municipal Spatial Agency

FDS — Fundamental Data Sets

FDSF — Foundation Spatial Data Framework

GeoTIFF — Geographic Earth Orbit Tagged Image File Format

GeoJSON — Geographic JavaScript Object Notation

GIS — Geographic Information System

GPS — Global Positioning System

GSDI — Global Spatial Data Infrastructure

GTCM — Geospatial Technology Competency Model

ICT — Information and Communication Technology

IFI — International Financial Institution

IHO — International Hydrographic Organization

INEGI — National Institute of Statistics and Geography (Mexico)

INSPIRE — Infrastructure for Spatial Information in Europe

IPDS — Institutional Arrangements, People, Data, Systems

ISO — International Standards Organization

JIGN — *Jaringan Informasi Geospatial Nasional* / National Geospatial Information Network

KML — Keyhole Markup Language

KPI — Key Performance Indicator

M&E — Monitoring and Evaluation

MSDI	Municipal Spatial Data Infrastructure	**TTL**	Task Team Leader
NGDA	National Geospatial Digital Archive	**UN-GGIM**	United Nations Global Geospatial Information Management
NSDI	National Spatial Data Infrastructure	**UNECA**	United Nations Economic Commission for Africa
NTWG	National Technical Working Group		
OGC	Open Geospatial Consortium	**UP**	Urban Performance Tool
OSM	Open Street Map	**URISA**	Urban and Regional Information Systems Association
PerDa	*Peraturan Daerah* / Local Regulation	**WMS**	Web Map Service
PerMen	*Peraturan Menteri* / Ministerial Regulation		
PerPres	*Peraturan Presiden* / Presidential Regulation		
PerWal	*Peraturan Walikota* / Mayoral Regulation		
Renstra	Rencana Strategis / Indonesia Strategic Plan		
RPJMD	Rencana Pembangunan Jangka Menengah Daerah / Indonesia Local Mid-term Development Plan		
SDI	Spatial Data Infrastructure		
SLA	Singapore Land Authority		
SNIEG	National System of Statistical and Geographic Information (Mexico)		
SOP	Standard Operating Procedure		

DATA

INSTITUTIONS

The world's cities are growing rapidly, and this expansion brings numerous challenges for urban populations. Economic growth often comes at the cost of quality of life for citizens and leads to uneven development.

Data is the new infrastructure. Building and managing geospatial data effectively will allow cities to make plans and policies that will work for their citizens, while effectively allocating limited resources. For instance, city officials will be able to use data as evidence to decide when transport services are most needed, where a new bridge should go and whether facilities are being used in a way that brings maximum benefit to citizens.

In order to enable this data-driven approach to urban planning and service delivery, **the World Bank City Planning Labs (CPL)** initiative has undertaken an ecosystem approach to **operationalize Municipal Spatial Data Infrastructure (MSDI)** in partner cities. It helps manage and maintain geospatial data through interventions across its agile and scalable four-pillared **IPDS framework (Institutional Arrangements, People, Data, Systems)**.

This manual (the first in a series) shares the experience gained by CPL after an intensive, hands-on, iterative development phase. It attempts to coherently document processes refined over two years of implementation in Indonesian cities. It offers solutions that are largely generalizable to other country contexts and is intended to contribute to **better decision** making that will ultimately lead to more equitable and sustainable development.

CITY PLANNING LABS (CPL): BUILDING DATA FOUNDATIONS FOR SMARTER, SUSTAINABLE CITIES

OVERVIEW

The last decade has witnessed an urban data revolution, as cities globally have started mobilizing geospatial information to harness the potential of urbanization. Governments are transforming the way they operate with the conviction that adding geospatial intelligence to urban service delivery systems will make it possible to do more with less.

The use of geospatial information allows for accurate, targeted and evidence-based decision making, thereby enhancing public sector cost savings. It also paves the way for boosting socio-economic development in cities by connecting people with jobs and services. Other positive impacts of spatially informed planning and urban management include reduced traffic congestion, increased safety, and enhanced climate change resilience. In sum, it enables a better quality of life for all city residents.
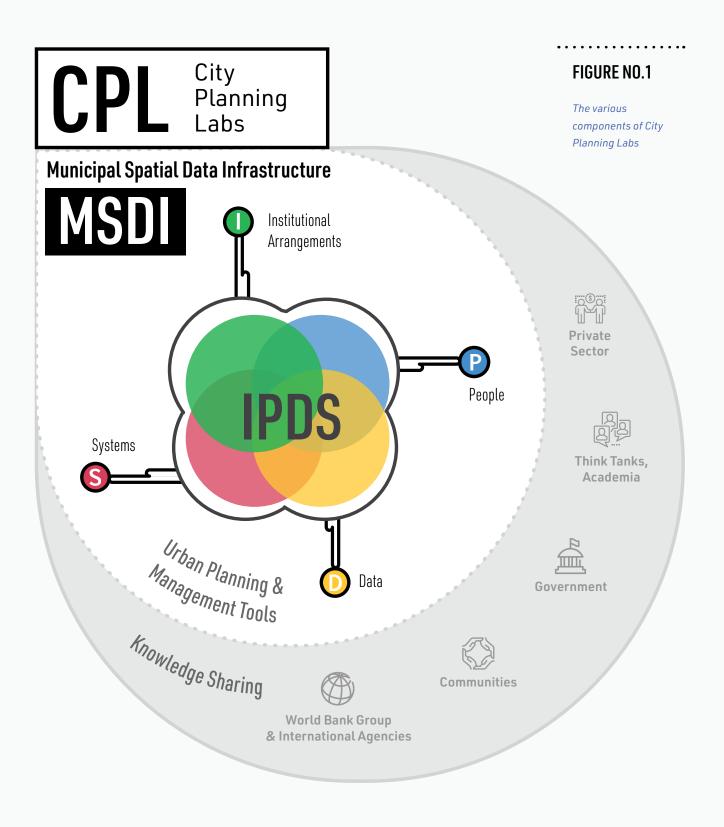
Recognizing this, the World Bank's Technical Assistance program, City Planning Labs (CPL), aims to strengthen the capacity of local governments to use geospatial intelligence to undertake data-driven planning and urban management. CPL assists cities by developing scalable and replicable tools that turn data

CPL City Planning Labs

into information and insights, while supporting the institutionalization and mainstreaming of data governance frameworks. CPL's foundational interventions create an enabling environment for geospatial innovations thereby helping cities deliver more efficiently on their core functions.

In the first phase of development, CPL has partnered with three Indonesian cities namely Semarang, Denpasar and Balikpapan. These cities have pioneered the implementation of CPL's innovative products and approaches, while simultaneously helping to refine the interventions in order to make them scalable and applicable to city governments beyond Indonesia. CPL has also drawn widely upon international good practices during the course of developing the program to ensure it is relevant globally.

Successes at the city level have been complemented by endorsement at the national level enabling the long-term sustainability of the initiative. For instance, national counterparts including the National Development Planning Agency (BAPPENAS), the Ministry of Agrarian and Spatial Planning/ National Land Affairs (ATR/BPN) and the Geospatial Information Agency (BIG) have encouraged the program to think at scale and transfer knowledge to build expertize within the country and replicate solutions without compromising innovation.

CPL City Planning Labs

Municipal Spatial Data Infrastructure

MSDI

I Institutional Arrangements

IPDS

P People

S Systems

D Data

Urban Planning & Management Tools

Knowledge Sharing

Private Sector

Think Tanks, Academia

Government

Communities

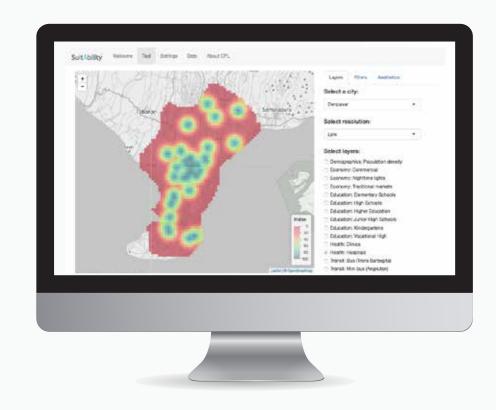World Bank Group & International Agencies

CPL UNIVERSE

In order to enable data-driven planning, CPL has undertaken an ecosystem approach to develop and operationalize a robust Municipal Spatial Data Infrastructure (MSDI) in partner cities.

MSDI functions as the platform by which geospatial information can be organized, shared, and leveraged to tackle the many challenges of sustainable urban development. Human, legal and technical aspects are an integral part of the MSDI framework, and inform the strategic investments needed by governments to support coordinated data-driven planning efforts.

CPL's MSDI implementation strategy has four pillars: Institutional Arrangements, People, Data, and Systems (the IPDS framework). Each of the pillars are representative of the key components that are necessary to support a digital infrastructure that is the MSDI. The pillar framework and its associated approaches and activities are modular, allowing for multiple entry points for the establishment of a functioning MSDI. Opportunities and entry points are highlighted through the preparation of a MSDI Roadmap with an accompanying Monitoring & Evaluation (M&E) framework, taking into account the immediate needs and available resources of the city government. Chapters 2,3 and 4 describe the various aspects of MSDI in further detail.

FIGURE NO.2

City Planning Labs
Urban Planning Tools-
Suitability Tool and
Urban Performance
Tool

URBAN PLANNING AND MANAGEMENT TOOLS

Building on the foundation of MSDI, innovative technological applications in the form of Urban Planning and Management Tools can simplify the utilization of data-driven approaches to address complex planning challenges. **Urban Planning Tools help cities analyze the patterns of urban growth and support the implementation of city-level strategic planning documents, such as spatial and sectoral development plans. Urban Management tools can include a range of areas such as capital investment planning and budgeting, asset management etc.**

Given the data intensive nature of some of these tools (requiring attention to robust data quality), the introduction of these tools should ideally be done in parallel with the establishment of MSDI to ensure sustainability. They also simplify consensus building since several actors can use a common platform to simulate their choices and compare performance results.

From an urban planning perspective, CPL has customized two tools, the Suitability Tool (ST)
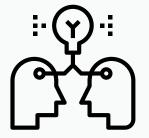
and the Urban Performance Tool (UP). The ST tool helps identify optimal locations for the implementation of projects or activities, while the UP tool forecasts the city's future performance by modeling specific policies or projects with a range of indicators. Both these tools are developed as open-source web applications which allow for ease of modifying, reuse and scaling up by other teams and users, given their minimal technical requirements. As these are web applications, it will also be possible to connect them to other online platforms (such as the geoportal) that cities may develop as part of an MSDI-implementation effort.

In addition, **CPL is also developing a pilot for spatially-informed Capital Investment Planning and Budgeting (CIP)**. It is aimed at helping city officials make decisions on the medium-term prioritization of their capital investments in a manner that strengthens the linkages between physical investment prioritization and spatial planning direction. Spatially-informed CIP can also enable local planning authorities and citizens to better understand the alignment between a city's capital investment plans and its development vision (e.g. poverty reduction goals, climate risk resilience targets etc.).

COLLABORATION AND KNOWLEDGE SHARING

Collaboration is at the core of CPL's initiatives, be it among the stakeholders that CPL is currently engaging, or with other teams, organizations and cities that are interested in implementing CPL's approach to data-driven planning. In accordance with this, many of the activities initiated under CPL are collaborative in nature, such as the co-creation of an MSDI roadmap (see Chapter 3) in collaboration with relevant city agencies. This ensures that proposed recommendations are sustainable and eventually mainstreamed. In the Indonesian context, the National Technical Working Group (NTWG) established as part of CPL is a platform for collaboration across agencies at the national level. This group also informs the policy direction, focus of partner cities, and scaling-up process to other cities in Indonesia.
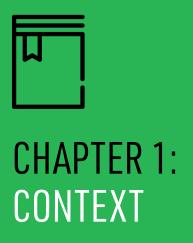
In addition to collaboration, **CPL also prioritizes knowledge sharing** across a range of actors including global peers and Indonesian cities through study tours, conferences, workshops and the preparation of toolkits based on lessons learned from the CPL experience. The target audience primarily includes (i) other cities in Indonesia, to foster peer-to-peer learning (ii) cities globally aiming to adopt the CPL approach to data-driven planning and (iii) other World Bank teams/international agencies.

In line with the scale-up phase, this manual is an attempt to share the knowledge and experience developed under CPL after an intensive, hands on, iterative development phase. The manual does not aim to be prescriptive, nor does it aim to diminish the critical importance of diversity of contexts. Rather, it attempts to coherently document the process that we have refined over the two years of implementation and offers solutions that we believe are generalizable to a large extent.

Collaboration is at the core of CPL's initiatives

CHAPTER 1:
CONTEXT

CHAPTER 1:
CONTEXT

PURPOSE OF THE MUNICIPAL SPATIAL DATA INFRASTRUCTURE (MSDI) MANUAL

Cities today are increasingly interested in utilizing the power of geospatial data to leverage the positive impacts of urbanization. The unprecedented creation and dissemination of data is a driver of growth and change, and a key resource for social and economic development. Geographical references provide constant information to help with daily decision-making. At the city level, mapping urban services together with population distribution and movement patterns enables decision-makers to harness insights to support evidence-led planning.

However, embarking on the journey to adopt data-driven planning is a complex one, replete with challenges both from a technical as well as a human resource perspective. It is a goal that cannot be achieved overnight and needs to be approached in a systematic yet iterative manner. Often, even while technical considerations can be addressed, changing mindsets is a slow and intensive

process. It is in this context that a manual for adopting MSDI as a means to achieve evidence-led planning is a critical resource for city governments.

This MSDI manual aims to serve as a simple, practical and innovative guide for cities, while documenting and addressing the complexities and challenges involved in operationalizing MSDI. It serves as an end-to-end reference document for city government officials to understand the baseline status of their spatial data infrastructure across its various core functions and institute MSDI with its various components to leverage innovation in technology for effective, efficient and sustainable use of data, in turn paving the way for improved urban planning and service delivery. Specifically, it includes the following:

- Equipping city governments to create an enabling policy and regulatory environment to implement MSDI

- Guiding cities to operationalize MSDI through an actionable roadmap across three time horizons

- Providing a structure to manage and share data

- Benchmarking against international examples, to inculcate awareness of the full spectrum of knowledge globally

STRUCTURE OF THE MANUAL

This manual comprises four chapters (including this one) and four annexes. Together, they provide a holistic view of the various facets of implementing MSDI:

1. CONTEXT:

This chapter provides context on the need for an MSDI Manual, the structure of the document (this section), how to use the document, its intended audience as well as a glossary of commonly used terms and definitions for easy reference.

2. MSDI OVERVIEW:

This chapter unpacks the concept of MSDI as a process and a product and describes various aspects of it, including the Institutional Arrangements, People, Data, Systems (IPDS) framework pillars in further detail. It also describes the need and use case of a roadmap to operationalize MSDI and outlines the key highlights in the roadmap development process.

3. BLUEPRINT FOR MSDI DEVELOPMENT:

This is the most important chapter of the manual as it provides a detailed description of the various steps involved in the development of an MSDI roadmap to create an actionable plan across short, mid and long-term horizons i.e., Horizons One, Two and Three. The approach consists of three steps:

1. Obtaining Initial Stakeholder Buy-In, Consensus Building Through a Diagnostic Review

2. Collaborative Identification of Opportunities and Recommendations

3. Finalizing the Roadmap

Each of these sections includes in-depth descriptions of sub-components and processes involved.

4. COMPONENTS OF MSDI OPERATIONALIZATION:

The first indispensable step towards this is providing the organizational structure and legal basis through the establishment of necessary MSDI regulations. Experience from application in City Planning Labs (CPL) cities proves that the Institutions pillar is the core pillar that will become the foundation for and is a precondition to the operationalization of People, Data, and Systems pillars. Thus, this chapter delves into further details across the aspects of the organizational structure and MSDI regulations ['How to' guides for interventions under the remaining pillars (People, Data, Systems) are forthcoming].
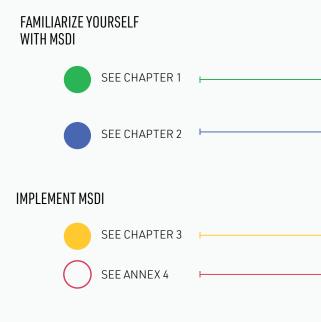
In addition, experiences from the three CPL partner cities are showcased to demonstrate how the MSDI-IPDS framework offers multiple entry points, allowing the flexibility cities need to harness their own strengths while adopting the framework.

These chapters are followed by four annexes:

1. **Annex 1:** Facilitation Formats
2. **Annex 2:** Guiding Principles for Formulating MSDI Regulations
3. **Annex 3:** MSDI Delivery Team Competencies
4. **Annex 4:** Questionnaires
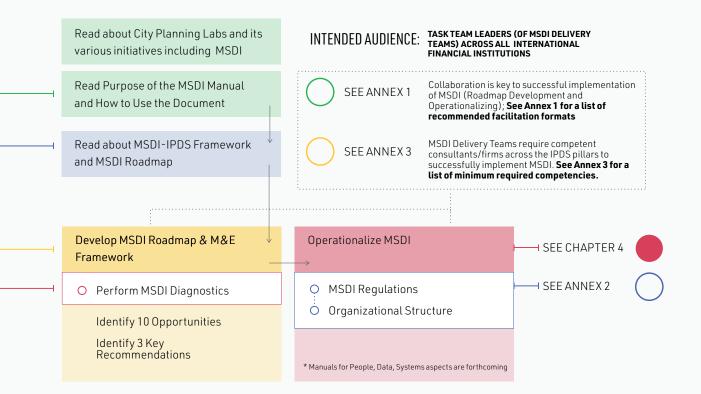
INTENDED AUDIENCE

Given the complexity involved in operationalizing MSDI, cities may require technical assistance from conceptualization to implementation. In this context, International Financial Institutions (IFIs) are appropriate partners, as they can bring in the necessary funding as well as technical expertize to realize various aspects of this effort. As such, **the primary users of this manual would be Task Team Leaders (TTLs) from IFIs across various country contexts**. Since CPL's MSDI-IPDS framework is modular, TTLs can chose multiple entry points depending upon the capacity and needs of the cities they are working in.

In instances where cities are already at an advanced stage of integrating a data-driven approach to their urban planning and service delivery, lead agencies within the government may be willing and able to take on operationalizing MSDI internally. In such cases, **this manual serves as a useful guide for senior officials as well as agency staff as they embark on this journey.**

Other possible users of this document could be policy makers and think tanks, urban development specialists, academicians involved in local governance, urban planning and management experts as well as members of the private sector.

FAMILIARIZE YOURSELF
WITH MSDI

● SEE CHAPTER 1

● SEE CHAPTER 2

IMPLEMENT MSDI

● SEE CHAPTER 3

○ SEE ANNEX 4

Read about City Planning Labs and its various initiatives including MSDI

Read Purpose of the MSDI Manual and How to Use the Document

Read about MSDI-IPDS Framework and MSDI Roadmap

INTENDED AUDIENCE: **TASK TEAM LEADERS (OF MSDI DELIVERY TEAMS) ACROSS ALL INTERNATIONAL FINANCIAL INSTITUTIONS**

○ SEE ANNEX 1 — Collaboration is key to successful implementation of MSDI (Roadmap Development and Operationalizing); **See Annex 1 for a list of recommended facilitation formats**

○ SEE ANNEX 3 — MSDI Delivery Teams require competent consultants/firms across the IPDS pillars to successfully implement MSDI. **See Annex 3 for a list of minimum required competencies.**

Develop MSDI Roadmap & M&E Framework

○ Perform MSDI Diagnostics

Identify 10 Opportunities

Identify 3 Key Recommendations

Operationalize MSDI

○ MSDI Regulations
○ Organizational Structure

* Manuals for People, Data, Systems aspects are forthcoming

SEE CHAPTER 4 ●

SEE ANNEX 2 ○

HOW TO USE THIS DOCUMENT

This manual describes the process and products involved in operationalizing MSDI in a holistic manner. One of the core strengths of the approach adopted in this manual is the flexibility it affords city governments to embrace various IPDS components. Depending on their current status of readiness for MSDI, it offers various options for city governments to commence or consolidate their data ecosystem. Thus, the document is organized such that users can directly refer to discrete components based on their own needs, queries and demands of programmatic initiatives.

The diagram above illustrates how to use and navigate this document.

COMMONLY USED TERMS AND DEFINITIONS

COMPETENCY ANALYSIS

A benchmarking and gap analysis of competencies that can inform capacity building strategies to meet workforce needs of city governments.

COMPETENCY FRAMEWORK

A framework that will enable target cities to identify the necessary competencies to operate an MSDI, and subsequently develop a geospatial workforce plan to ensure the availability of geospatial manpower to continuously sustain its operations.

DATA ACCESS

Conditions that determine the authority to access data repositories, and share data, based on data ownership, formats, legal obligations, privacy and data security, etc. These are typically determined by user types (e.g., internal and public users, etc), or sensitivity of the data itself (e.g., private individual data, public/ open data, etc).

DATA CHAMPION

A person that serves as an agency's main point of contact for other agency inquiries on data-related matters, be it verifications, updates, or access to restricted datasets.

DATA CUSTODIANSHIP

Refers to the responsibility to ensure that data is properly maintained: up to date, up to standards, secure, accurate, properly managed and stored, usable, available for dissemination etc. This responsibility is typically assumed by a data custodian.

DATA GOVERNANCE

A concept of data management that allows organizations to ensure that data is available, usable, and consistent throughout its lifecycle. This may include processes, guidelines, key stakeholders, or roles and responsibilities of relevant stakeholders.

DATA MANAGEMENT

Activities and processes of managing data throughout its lifecycle, i.e. data collection, storage, access and sharing.

DATA STANDARDS

Rules and specifications for the structure, content and terminology of geospatial information. In the context of MSDI, standards can serve as a tool to ensure interoperability and usability of geospatial datasets by various stakeholders.

FINANCIAL ARRANGEMENTS

City wide and departmental budgetary allocations to create and sustain MSDI.

FUNDAMENTAL DATA SETS

Fundamental datasets are defined as the core datasets that form the common reference for the production of all other geospatial datasets. They represent the lowest common denominator of data requirements or a base map, from which all other geospatial data for various sectors can be produced.

GEOCOMMUNITY

Geospatial taskforce that aims to address a particular issue using geospatial approaches. This taskforce convenes experts across agencies and institutions to develop geospatial solutions for a city issue, by aggregating data and resource needs and developing practical strategies to meet those needs.

GEOPORTAL

A platform for geospatial data and information exchange.

GEOSPATIAL DATA

Data that has location components, such as geographic coordinates, addresses and postal codes.

GEOSPATIAL STRATEGIC WORKFORCE PLANNING

Is an exercise that governments or organizations may wish to conduct in order to plan for their geospatial workforce needs. This exercise may include a review of existing geospatial workforce available within their organization, a study of the organization's geospatial workforce needs, and potential sources of geospatial workforces to inform recruitment or training plans to plug geospatial capacity gaps.

IPDS FRAMEWORK

IPDS (Institutional Arrangements, People, Data, Systems) is an organizing four- pillar framework required to effectively implement MSDI. Each of these pillars have scalable, agile and replicable products that can be utilized to develop MSDI in any city across the globe.

METADATA

A component of data standards, which specify standardized descriptions that clarifies data. This includes information on physical storage methods, content, ownership, lineage, resolution, extent of coverage, etc.

MSDI REGULATIONS

Policies and regulations to operationalize and sustain MSDI. They articulate IPDS, outline protocols for enabling effective workflow and data sharing as well as provisions for budgetary allocations.

MSDI ROADMAP

Delineates the purpose, goals and steps to be taken by the city government to operationalize MSDI. It identifies key actions required across three time horizons – short, medium and long – required for the implementation of MSDI.

MSDI WORKING GROUP

The group in charge of the successful implementation of MSDI. The group's responsibilities, among others, are to coordinate MSDI-related activities, establish standards and specifications of geospatial data management, and enhance the capacity of city agencies to utilize geospatial data.

MUNICIPAL SPATIAL DATA INFRASTRUCTURE (MSDI)

The platform and process by which geospatial information can be organized, shared, and leveraged to tackle the challenges of sustainable urban development.

NATIONAL SPATIAL DATA INFRASTRUCTURE (NSDI)

A national-level framework that is comprised of technology, policies, standards and human resources that can enable effective utilization of geospatial data.

TASKFORCE

An ad-hoc forum that is created to address a particular issue in the city using geospatial information.

URBAN PLANNING AND MANAGEMENT TOOLS

Key applications that help cities analyze the patterns of urban growth and support the implementation of city-level strategic planning documents, such as spatial and sectoral development plans.

CITY PLANNING LABS (CPL) PRODUCT LIST

The table below summarizes the CPL Product List. Each of these are described across various chapters of the manual and this comprehensive list is for easy reference. The products listed here have been developed by CPL and are available for use by any interested stakeholders.

PRODUCT NAME & FORMAT	HOW THIS HELPS CITY GOVERNMENTS	ROLE OF THE MSDI DELIVERY TEAM/ CONSULTANTS
Rapid MSDI Readiness Assessment *Survey instrument & methodology notes*	Develop a common, high-level understanding of the current status of the city's MSDI readiness across the Institutional Arrangements, People, Data and Systems (IPDS) enabling components.	Explain the purpose of the survey and administer it. Perform the rapid assessment based on the survey's methodology, present the results, and facilitate a discussion with city officials on the results.
Geospatial Prioritization Survey *Survey instrument*	Arrive at a consensus on sectors to be prioritized from a geospatial development perspective. Align MSDI interventions with sectoral priorities.	Explain the purpose of the survey and administer it. Perform rapid assessment and extract a list of priority city sectors. Engage key stakeholders to validate the results of the survey and facilitate a larger discussion with agency officials to gain buy-in on the identified priority sectors.
Deep Dive MSDI Capacity Assessment *Survey instrument*	Gain a detailed understanding of the baseline condition of MSDI – IPDS pillars in the city.	Explain the purpose of the survey and administer it. Use the findings of the survey to inform MSDI Roadmap recommendations.
Data Inventory Survey *Survey instrument*	Gain a comprehensive understanding on the data that is available in the city, including detailed information about the data itself (e.g. custodian agency, data producer, last update, format etc.).	Explain the purpose of the survey, administer the survey via one-on-one meetings with individual agencies' data representative. Consolidate the survey results for further analysis, and think of possible ways to immediately leverage data to perform analysis.
Baseline Fundamental Data Sets (FDS) List *FDS sample list*	Understand the importance of FDS to support new geospatial data production. Learn about various international FDS benchmarks, and adopt one that is appropriate for the city's context.	Explain the definition and usefulness of FDS. Identify the prevailing FDS list in the implementation context, or guide officials to develop an FDS list in the absence of an existing one.

PRODUCT NAME & FORMAT	HOW THIS HELPS CITY GOVERNMENTS	ROLE OF THE MSDI DELIVERY TEAM/ CONSULTANTS
FDS Assessment Toolkit *R Markdown & FDS Keyword Matrix*	Gain an understanding of how the city is positioned in terms of FDS completeness and gaps, and by extension, their capacity to produce new geospatial data.	Perform the assessment following the methodology outlined in the R markdown document, (using the result of Data Inventory Survey and Baseline FDS keyword matrix as inputs). Help officials to think about which FDS to acquire, in alignment with their priority sectors identified in the Geospatial Prioritization Survey.
MSDI Roadmap *Sample MSDI Roadmap*	Understand the importance of an MSDI roadmap and associated IPDS components to ensure sustainable implementation. Learn how the roadmap can be developed using the process provided.	Reference the methodologies outlined in the sample roadmap to gather required information, engage relevant stakeholders, and synthesize the results of surveys and workshops to inform the development of an MSDI Roadmap.
Framework for MSDI regulations *Regulatory framework*	Identify the set of elements to be regulated, in order to implement MSDI using the IPDS framework.	Help cities understand the components to be regulated, and contextualize the international examples cited in the regulation framework, where relevant. Assist in the development of regulations using the framework provided.
Geospatial Capacity Building Modules *Training modules*	Initiate a series of geospatial training for the city's technical staff, in order to fill immediate gaps in geospatial competencies.	Perform a preliminary geospatial capacity building exercise in the city. Help cities think of additional capacity gaps that may need to be filled.
Urban Planning and Management Tools Capacity Building Modules *Training modules*	Initiate training for CPL's Urban Planning and Management Tools to improve cities' awareness on the potential benefits of geospatial data. Perform immediate analysis relevant for priority sectors using the tools.	Initiate training on the tools. Facilitate discussions based on the analysis provided by the tool. Explore how these can be integrated with existing city applications/ portals.
Master Terms of Reference for Geoportal Development *Sample Geoportal Development Terms of Reference*	Gain an understanding on the state of the city's existing geoportal (if a portal already exists); its adherence to international standards, and functionalities. Understand the benefits of a geoportal for the city, and initiate efforts to improve existing/ develop a new geoportal, based on needs.	Explain the concept and function of a geoportal to city officials; perform necessary assessments of existing spatial data portals, gather user requirements, and recommend improvements/ new developments as necessary. Contingent on the city's request, execute the recommendations to enhance the existing portal/ develop a new geoportal.

CHAPTER 2:
MUNICIPAL SPATIAL DATA INFRASTRUCTURE (MSDI) OVERVIEW

CHAPTER 2:
MUNICIPAL SPATIAL DATA INFRASTRUCTURE (MSDI) OVERVIEW

"In the 21st Century, data is infrastructure."

– National Infrastructure Commission, United Kingdom

DATA AS INFRASTRUCTURE

With Spatial Data Infrastructure, data is essentially treated as a piece of infrastructure. If we take the example of a common type of infrastructure such as roads, and think about the elements that enable a road to function, we can understand that roads (or any infrastructure) are not able to operate without supporting elements. Road infrastructure needs regulations that determine mutually agreed upon, acceptable driving behavior (for example, drunk-driving or texting while driving is illegal). Roads also need workers for repairs and regular maintenance (through Public Works) and traffic and public transportation management (through the Transportation agency). Lastly, roads must be planned, managed, and treated as part of a system. Roads can only function as part of a road network - a single road segment offers limited benefits to its users. All of these supporting elements need to be in place to enable the responsible and efficient use of road infrastructure.

Proper data utilization requires similar supporting elements. Much like roads, the use of data should be regulated by policies (for example, making it illegal to access private information without necessary authorization). Staff with the relevant educational background are required for data maintenance and updates, validating datasets (a role currently taken up by the Statistical Agency), or verifying that data complies with certain standards (often the Geospatial Agency in the case of spatial data). Lastly, just like roads, data need to exist within a system, alongside other datasets.

Creating an environment where validated data can be freely accessed and shared will allow users to access information, complete analysis and derive insights beyond what is feasible with a single dataset. 'Road infrastructure' can be used interchangeably with 'roads' to refer to all of the combined elements that make up road infrastructure. In the case of 'data', we refer to data and its enabling components collectively as Spatial Data Infrastructure (SDI), or MSDI at the city level.
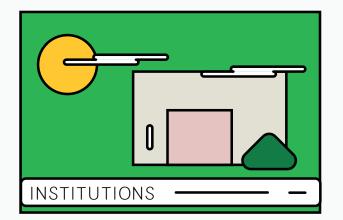
SPATIAL DATA INFRASTRUCTURE (SDI)

SDI functions as the platform by which geospatial information can be organized, shared and leveraged to tackle the many challenges of sustainable development. Human, legal and technical aspects are an integral part of the SDI framework, which is rapidly gaining importance as a strategic investment for governments to support coordinated data-driven planning efforts.

At the national level, the establishment of a National Spatial Data Infrastructure (NSDI) with policies and frameworks has been recognized as an effective vehicle for facilitating seamless data development, information sharing, and collaborative decision making across multiple sectors of the economy. Many national governments, including the Government of Indonesia where the CPL initiative has advanced, have an overarching NSDI in place. However, the extent of implementation varies across countries and in many cases NSDI has remained at the policy level.

In addition, despite the usefulness of an overarching national mandate, efforts to develop SDI at the national level are not sufficient to address bottlenecks in data informed decision-making at the city level. With dynamic forces of urbanization and rapid uptake of geospatial data and technology, cities are ideally placed to become SDI champions, given their unique position within the national government hierarchy. Cities are positioned close enough to the community to allow them to directly learn about the relevant priority issues, and yet high enough within the hierarchy to propose their own solutions, be it in the form of programs, policies or regulations. Against this backdrop, the World Bank's CPL initiative is committed to supporting city governments to develop and operationalize the much-needed MSDI.
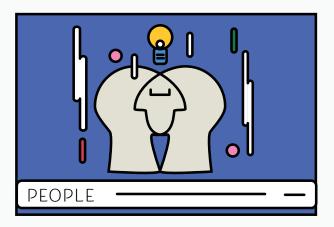
THE MSDI-IPDS FRAMEWORK

CPL has developed an ecosystem approach for MSDI implementation with a framework organized across four pillars: Institutions, People, Data and Systems (IPDS). These four pillars offer a holistic approach to the establishment, functioning and monitoring of MSDI implementation across short, medium, and long-term horizons. The four pillars do not stand alone but function in an interconnected manner. This interaction across components of the IPDS framework is crucial to establishing an effective MSDI. Once implemented, city departments and officials are equipped with capabilities pertaining to strategic thinking that enable them to internalize the process, steer it, improve administration of the regulatory requirements, and develop technical skills to operationalize data management.

INSTITUTIONS
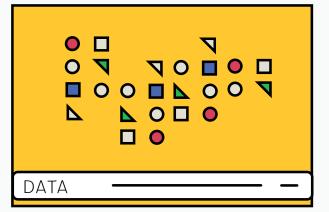
INSTITUTIONAL ARRANGEMENTS

Refers to the capacity of cities to develop and sustain formal policy, regulatory and governing structures that support geospatial related activities, and to the role of the city government in fostering the growth of the broader geospatial ecosystem.
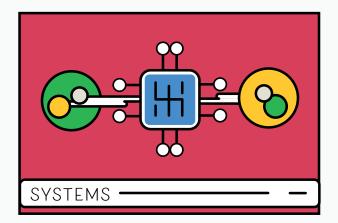
PEOPLE

Refers to creating an awareness of capacity needs and identifying gaps in human resource supply with respect to geospatial skills. It addresses the skills gap in the production, maintenance, and utilization of spatial data.

DATA
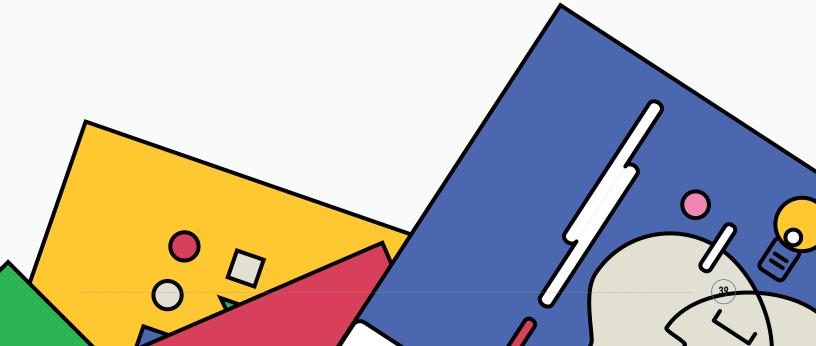
Refers to the current state of affairs on data availability, quality and related policies regarding formats, analysis and sharing of geospatial information. This diagnostic also considers the business case for investment in data and the extent to which the use of geospatial information can add value to existing city agency Key Performance Indicators (KPIs).

SYSTEMS

SYSTEMS
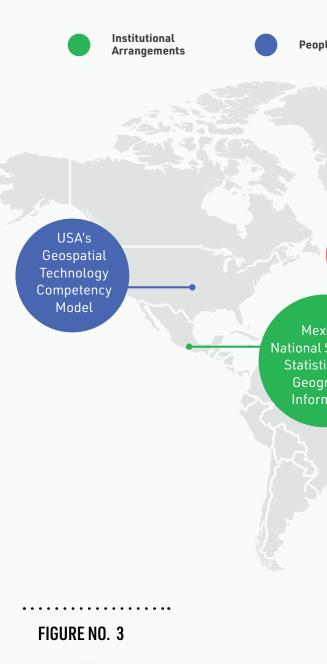
Refers to software, hardware and physical Information Technology (IT) related infrastructure required to support MSDI. A key component lies in the adequacy, functionality and user interface of the city-level geoportals that combine Geographic Information System (GIS) and spatially referenced tabular data.

Developed in collaboration with the Singapore Land Authority (SLA), the IPDS framework is based on a thorough review of ten international benchmarks, calibrated for the challenges faced by urban local governments. The following section describes MSDI in greater detail.

BOX 1: INTERNATIONAL BENCHMARKS FOR MSDI

Studying international benchmarks helps understand best practices and aspirational goals to implement MSDI effectively. Key highlights across the IPDS components are described below and have been factored into the development of MSDI Roadmaps for CPL partner cities.

Institutional Arrangements

Peopl

USA's Geospatial Technology Competency Model

Mex
National
Statisti
Geog
Inform

FIGURE NO. 3

Global IPDS Benchmarks

Data · **Systems** · **Institutional Arrangements + Data**

France's National Geoportal

United Kingdom's Geovation Hub

Korea's National Integrated Information System

...ico's ...System of ...cal and ...raphic ...nation

Singapore's SG-SPACE Geospace & OneMap

Indonesia's National Geospatial Information Networks

South Africa's Johannesburg Data Governance Regualtions, Protocols

Australia & New Zealand's ANZLIC Foundation Spatial Data Framework

BOX 1:

Institutional Arrangements. The global IPDS benchmarks demonstrate the effectiveness of comprehensive networks for coordinating data management and sharing vertically and horizontally. Appointment of a lead agency by law is also key to building mandate and will.

For example, **Mexico's National System of Statistical and Geographic Information (SNIEG)** combines both statistical and geospatial domains to produce high-quality, integrated data for national development. Appointed as SNIEG's lead agency by law, the National Institute of Statistics and Geography (INEGI) coordinates the cross-linking and dissemination of statistical and geospatial data for various application areas. These application areas are in turn organized into National Information Subsystems, which execute geospatial and statistical activities through committees and working groups that span sectors and government levels[1].

In Indonesia, several laws provide a legal basis to formalize local data sharing arrangements and governance roles. A system of Presidential (PerPres), Ministry (PerMen), Mayoral (PerWal),

and Local Government (PerDa) Regulations, characterize the laws. Law No. 4/2011 establishes a government mandate to facilitate the development of geospatial information and defines the NSDI framework to consist of policies, institutions, technology, standards and human resources. Moreover, **it assigns responsibilities for base map and thematic map creation to the National Geospatial Information Agency (BIG) and local governments respectively.**

Indonesia's PerPres No. 9/2016 complements this law by implementing the One Map policy, which aims to quicken the uptake of data for use by creating a single geo-reference, geo-database, geo-standard, data custodian, and data version. In turn, PerPres No. 27/2014 operationalizes this policy by creating the National Geospatial Information Network (JIGN), which comprises network nodes across government ministries and local agencies. These nodes are designated as production units, and management and dissemination units[2].

These laws will provide the thrust needed to streamline local roles and processes along the data supply chain, such as the appointment of MSDI Steering Committee members, MSDI working

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1   INEGI. (2017). Mexico's National Geostatistical Framework, and Geospatial Tools for the 2020 Population and Housing Census. Retrieved from: http://ggim.un.org/ggim_20171012/docs/meetings/GGIM7/3%20-%20Rolando%20Ocampo%20Alcántar.pdf

2   Setiawan, I., Sutanta, H., Rachmat, S. Y., and Gularso, S.K. (2016), Geospatial Technical Support Final Report.

units, geoportal administrator and managers, and GIS agents[3,4,5].

People. There is merit in creating a physical avenue to convene expertize across various city departments where cross-domain synergies can flourish.

In the long term, a competency model can support industrial growth by aligning strategic city/country directions with the industry and academia. For example, the United States **Department of Labour uses a comprehensive Geospatial Technology Competency Model (GTCM) to build geospatial competencies among students and the workforce**. The GTCM articulates the core and specialized skills and knowledge needed for successful performance across different tiers of practice, from the most general "Personal Effectiveness Competencies" to sector-specific competencies[6].

Data. It is important for any aspiring data clearinghouse to work towards the integration of geospatial, administrative (often textual data), policy and statistical data. A systematic strategy plan needs to be drafted, including the identification of Fundamental Data Sets (FDS). The list of FDS should then be taken as first-priority in any SDI-related effort and allows for a consistent approach to tackling data quality and management issues.

A good example is the **Australian New Zealand Land Information Council (ANZLIC)'s Foundation Spatial Data Framework (FSDF)**. The FSDF ensures the seamless exchange and widespread accessibility of national-level foundation spatial data in Australia and New Zealand. It identifies fundamental geospatial data themes, which underpin key applications, and recommends a common approach to assembling and managing them. Principles for custodianship, privacy, security, intellectual property, licensing and access are covered in the FSDF[7].

Systems. It is crucial to consider both internal and external stakeholders when designing geoportals. There are merits to have an internal-facing (government-only) geoportal to facilitate inter-departmental data sharing and similarly, an external-facing (public-facing) geoportal is useful for disseminating information to the community.

3   Ikäheimo, A. and Milla L. (2017), MSDI Assessment and Roadmap: City of Semarang

4   Ikäheimo, A. and Milla L. (2017), ibid

5   Setiawan, I., Sutanta, H., Rachmat, S. Y., and Gularso, S.K. (2016), ibid

6   United States Department of Labour. (2014). Geospatial Technology Competency Model. Retrieved from: https://www. careeronestop.org/CompetencyModel/competency-models/pyramid-download.aspx?industry=geospatial-technology

7   ANZLIC. (2012). The Australian and New Zealand Foundation Spatial Data Framework: Making Common Foundation Spatial Data Ubiquitous Across Australia and New Zealand. Retrieved from: https://www.linz.govt.nz/system/files_force/media/pages-attachments/ ANZ_FoundationSpatialDataFramework_%28FinalWeb%29.pdf?download=1

BENEFITS OF MSDI

Key benefits of an operational MSDI are:

- Improving service delivery through enhanced access to information and creating a decision-making process that is evidence-led.

- Informing the KPIs of city plans (e.g., mid-term development plan and sectoral strategic plans) such that they include priority activities and outputs of the MSDI roadmap.

- Stimulating greater capability and accountability across government departments to adopt a data-driven approach towards making competitive, inclusionary and sustainable cities.

- Generating solutions to cross-jurisdictional and sectoral issues faced by cities. This implies linking services across national, state, and local jurisdictions – including various departments, sectoral stakeholders and organizations.

- Facilitating and coordinating the sharing of geospatial data across city agencies, based on a dynamic set of protocols that enable effective coordination between departments and help cultivate a collaborative work ethic. For example, if the city's goal is to alleviate the problem of congestion in cities, information from a range of departments including mobility patterns of all modes of transport, street hierarchies, land use, location of environmentally sensitive areas, bio-diversity, pollution levels, to name a few, will be accessible across all sectors.

- Create and facilitate a common data repository, and a public facing geoportal which will help city agencies to access and analyse information to support evidence-led planning.

MSDI ROADMAP: NEED AND USE CASE

At the inception stage, city agencies often find it challenging to comprehend the various interrelated components of MSDI, and their own roles and responsibilities in ensuring implementation.

The MSDI roadmap addresses this issue by delineating the purpose, goals and a set of steps to be taken by the city government, to lead the process of collaboratively implementing MSDI. **It identifies approach to identifying key actions required across three time horizons – short, medium and long – required for implementation**. In most cases, the city government will need to ratify a decree so that an MSDI has a legal basis, and its programs and activities can be conducted. The provision of a legal basis for the MSDI may need to be done at different levels of the government – national, provincial and city, depending on the country context. The process of developing the roadmap also involves:

- Imparting an understanding of the conceptual dimensions of MSDI and its ability to help fulfil the city's long-term visions and goalsfor all city stakeholders.

- Setting of goals and requirements identified in the MSDI vision and strategy plan.

- Translation of these goals and requirements into key activities and processes within the IPDS framework, phased across time horizons.

- The development of a Monitoring and Evaluation (M&E) framework to track the progress of anticipated outcomes.

- Delineation of key capabilities and competencies needed to execute these activities and processes.

- Allocation of budgets and timing considerations recommended key activities.

HIGHLIGHTS OF THE ROADMAP DEVELOPMENT PROCESS

LED AND OWNED BY GOVERNMENT

The success of MSDI rests in the city taking complete ownership of the process and products. In an ideal situation, priority activities from the MSDI roadmap must be included as KPIs in the city's mid-term development plan as well as sectoral strategic and spatial plans. While the complexity of the process often requires governments to obtain support in the form of technical assistance, the process and its outcomes are led and owned by the government. In addition to quantifiable improvements towards data-driven planning, the long-term benefits of a well-functioning MSDI include enhanced transparency and accountability which in turn leads to improved service delivery, public trust and a better quality of life for citizens.

INCLUSIVE AND COLLABORATIVE

MSDI roadmaps are developed collaboratively with agencies for short, medium, and long-term horizons. The approach is, at all times, consultative with an emphasis on establishing a culture of inter-agency collaboration. The importance of collective knowledge and experience of city officials is critical as they will provide their perspectives on the benefits and challenges of implementing MSDI.

MULTIPLE ENTRY POINTS: FLEXIBILITY

Within the IPDS framework, city governments can identify and prioritize activities that will serve as entry-points for introducing, operationalizing and socializing MSDI activities across all stakeholders. While developing their MSDI roadmap, armed with the results of baseline assessments, some cities may first decide

to focus their efforts on developing legal and regulatory foundations for data management activities – these may include formulating local government decrees for data governance and management, or protocols for data sharing or framing data standards to improve coordination between city agencies. Other cities may prioritize preparation of citywide base maps and other data development activities to help assess infrastructure needs. Still others may use skills development, capacity building or establishing the geoportal as entry points to introducing citywide MSDI. Such an approach enables **working with existing initiatives as entry points rather than prescribing a rigid set of linear recommendations with inflexible start and end points.**

ITERATIVE AND AGILE

The process of developing the MSDI roadmap is designed to afford agility that allows city governments to adapt the framework based on their priorities and capabilities. **The MSDI roadmap is a living document i.e., as the city's priorities can change over time, the document should be flexible and agile to incorporate the same.** In addition, as the MSDI implementation is underway, there may be specific challenges which may necessitate reiterating the roadmap.

COMPREHENSIVE

The IPDS framework considers **governance and regulatory functions alongside technology solutions** but also takes into account the **importance of human resources** to boost data foundations.

SCALABLE

The IPDS framework is flexible and scalable, implying **cities with varying levels of capacity and at different stages of MSDI development can leverage and build on the framework.**

MSDI: IS IT A PRODUCT OR A PROCESS?

Institutionalizing MSDI within city governments entails persistence and sustained effort. It involves engaging in a **highly collaborative process of developing an MSDI roadmap**, which contains key recommendations factored across the short, medium and long-term horizons, in alignment with the city's urban development priorities. The roadmap and the recommendations contained within it are developed through a series of consultative meetings and workshops with relevant city officials.

The need for MSDI to align with the city's urban development priorities suggest that the MSDI roadmap - its products, activities, and milestones - should also be agile and adapt to any changes in urban development priorities, as well as the implementation of individual activities and programs under it.

It is in this context that **MSDI and its operative IPDS framework can be seen as an evolving process that includes the design and development of products, regulatory frameworks and technological solutions** in a collaborative manner. Assisting city governments to use this approach enables their agencies and officials to internalize the process, steer it, improve administration of the regulatory requirements, and develop technical skills to operationalize data management.

Using the organized structure of a roadmap, **MSDI also comprises products across its four framework pillars (IPDS) which help achieve the expected outcomes**.

Given the feedback loop between MSDI outputs (e.g. collaborative groups, Fundamental Data Sets (FDS) exercise, enhanced geospatial staff capacity) and the MSDI itself, MSDI can be thought of as a process, as much as it is a product. For example, the increased technical capacity of staff enables better analysis, which in turn positively influences urban planning. This can further translate into higher awareness of the benefits of geospatial data among senior officials, influencing decision-making and data-driven planning.

"MSDI can be thought of as a process, as much as it is a product."

CHAPTER 3:
BLUEPRINT FOR MUNICIPAL SPATIAL DATA INFRASTRUCTURE (MSDI) DEVELOPMENT

Three step process to an MSDI roadmap

CHAPTER 3:
BLUEPRINT FOR MUNICIPAL SPATIAL DATA INFRASTRUCTURE (MSDI) DEVELOPMENT

Developing a robust MSDI is a complex endeavor as its components and requirements vary greatly by city. Given this, there is no one-size-fits-all approach to it and it is important to lay the right foundation upon which cities can customize, based on their specific needs and capabilities.
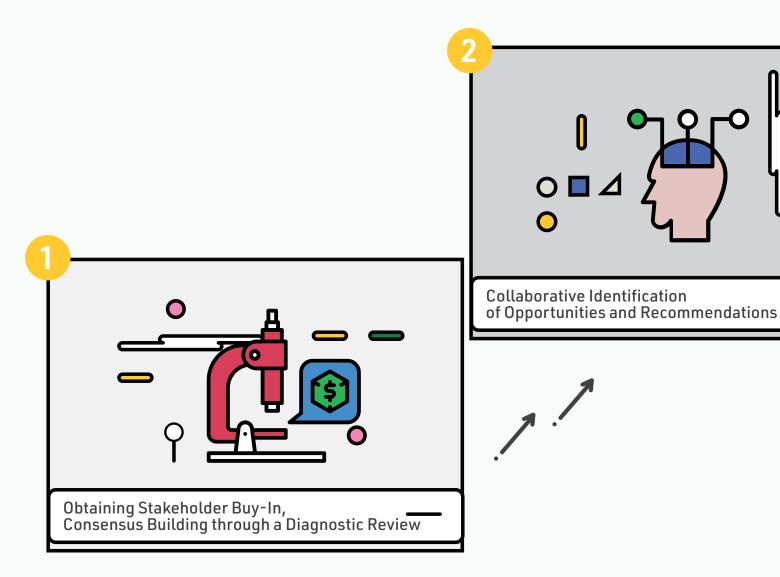
An MSDI roadmap provides this foundation by delineating the purpose, goals and a set of steps to be taken by the city government, to lead the process of collaboratively implementing MSDI.

This chapter outlines the steps involved in the development of an MSDI roadmap in detail.

THREE STEP PROCESS TO AN MSDI ROADMAP
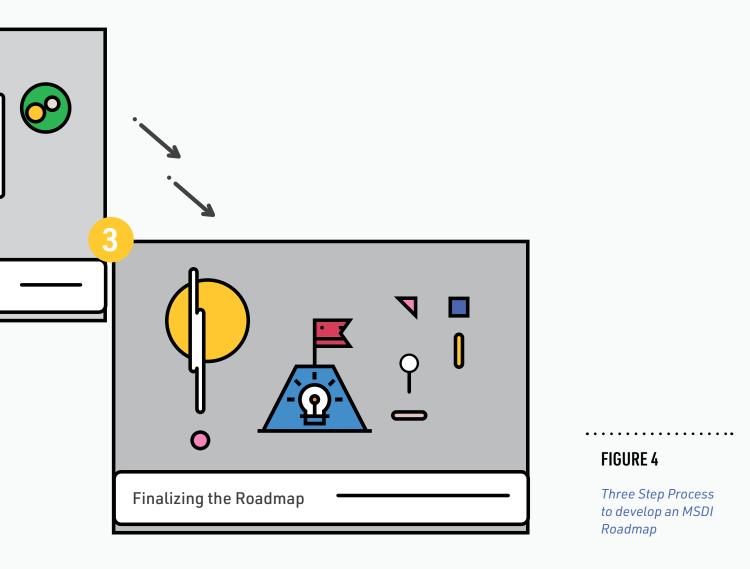
The development of the roadmap comprises three key steps:

1 OBTAINING INITIAL STAKEHOLDER BUY-IN, CONSENSUS BUILDING THROUGH A DIAGNOSTIC REVIEW

2 COLLABORATIVE IDENTIFICATION OF OPPORTUNITIES AND RECOMMENDATIONS

3 FINALIZING THE ROADMAP

1

Obtaining Stakeholder Buy-In,
Consensus Building through a Diagnostic Review

2

Collaborative Identification
of Opportunities and Recommendations
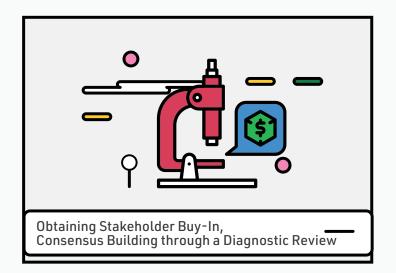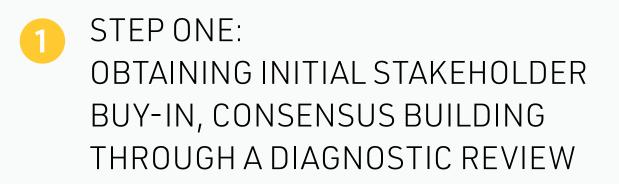
PROCESS CONSIDERATIONS AND TIMELINES

Depending on the capacity of the city and the level of stakeholder buy-in, each of these steps can take from one to three months. In the initial stages of the process, multiple meetings and workshops will be required, especially with key stakeholders, to ensure smooth progress. Once the city has demonstrated clear interest and engagement, the stakeholders can be expected to advance the various aspects within set, shorter timeframes.

Finalizing the Roadmap

In addition to timelines, another important consideration to factor in is the need to be flexible. If the MSDI delivery team has a strong existing relationship with the city, especially its technical staff, some components of the diagnostic review may be initiated concurrently along with engaging senior officials for buy-in. However, in case the engagement is new, it may be critical to first convince key city leaders before embarking on technical diagnostic reviews.

Obtaining Stakeholder Buy-In,
Consensus Building through a Diagnostic Review

1 STEP ONE:
OBTAINING INITIAL STAKEHOLDER
BUY-IN, CONSENSUS BUILDING
THROUGH A DIAGNOSTIC REVIEW

OBTAINING INITIAL STAKEHOLDER BUY-IN:

"Developing a successful Spatial Data Infrastructure (SDI) initiative depends at least as much upon issues such as political support, clarifying the business objectives which the SDI is expected to achieve, sustaining a culture of sharing, maintaining reliable financial support and enlisting the cooperation of all members of the community, as upon technical issues relating to spatial data access, networking and standards. Therefore, developing a successful SDI within a jurisdictional level must be seen as a socio-technical, rather than a purely technical exercise."

(Abbas Rajabifard, President, Global Spatial Data Infrastructure Association)

LEADERSHIP ENDORSEMENT:

For successful implementation, buy-in and support from key officials at the executive level such as the Mayor, Vice Mayor or City Secretary is of paramount importance.

Obtaining this endorsement can be remarkably straightforward in cases where the demand and understanding of geospatial interventions and the need for long term solutions exists. However, vision building can be more complicated in cities where awareness of the importance of geospatial data is relatively low. In cities where the Smart City vision is key, it is important to make a case linking MSDI (and its foundational role in enabling data-driven planning) to Smart City initiatives to garner high-level endorsement. Regardless of the level and nature of demand in the city, aligning the geospatial agenda of MSDI with priority city initiatives and demonstrating its practical application in achieving the city's vision is likely to convince senior officials more easily.

As their leaders guide the work of city agencies, support from officials can encourage or even ensure active participation of agencies. Consequently, once this aspect has been addressed, further engagement on next steps is likely to be more streamlined and effective. Having said that, it is important to underscore that high-level endorsement from city leadership is only one small aspect of city buy- in. From an implementation and sustainability perspective, multiple champions are needed at all levels of decision making, most importantly among the technical staff who carry the agenda on their shoulders and have a deep understanding of the operational constraints, inter-agency dynamics and technical limitations of their teams (see Box 3 on Data Champions).

TIP

Meetings with senior officials needs to be planned carefully. Inviting many senior leaders to one meeting may be difficult. Thus, in order to make discussions fruitful and efficient, a smaller meeting with the top official (Mayor) or their second-in-command (Vice Mayor, City Secretary) can be organized. During the meeting it is important to get written (preferable) or verbal commitment for the city to adopt MSDI (see Annex 1 for details on facilitation formats across all stages of the roadmap development and implementation).

BOX 2: SIGNING A COMMITMENT LETTER: THE CASE OF SEMARANG CITY

In order to ensure full ownership of MSDI implementation, obtaining written commitment from high level authorities of the city government is vital. In this regard, the city of Semarang offers useful experiential learning.

In the early phases of the CPL initiative, engagement was limited to more senior officials of the City Development Planning Agency (BAPPEDA). Officials were enthusiastic and passionate, but with scheduled rotation of these key members to other departments, it became evident that a wider engagement strategy must be embraced. With no formal knowledge transfer, the impetus for implementing various data-driven planning initiatives had reduced.

This drop in momentum coincided with CPL's launch of the holistic MSDI overview and allowed for the shift from a key stakeholder consultation approach to a wider collaboration model. In addition, it was evident that receiving a clear commitment from the highest levels of governance (i.e., Mayor) was critical to ensuring short-term progress as well as long-term sustainability. Thus a Letter of Commitment was signed between the city Mayor and the World Bank. This helped provide a full overview of CPL-MSDI activities and its advantages to him while simultaneously communicating high-level buy in, thereby inspiring agency staff. It also provided the basis for BAPPEDA to reach out to other agencies for their contributions. It must be noted that obtaining a high-level agreement demands the deployment of multiple strategies on part of the facilitation team.
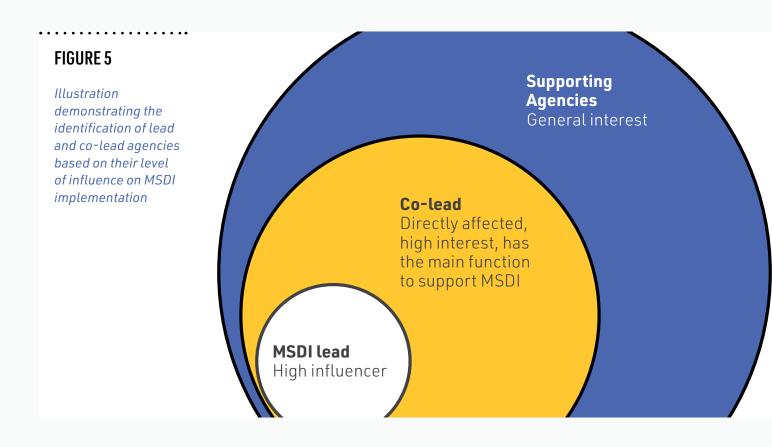
KEY STAKEHOLDER IDENTIFICATION AND ENGAGEMENT:

Given that the implementation of MSDI is an inclusive effort, it is crucial to understand all the stakeholders who will be involved in this process. It is also equally critical to identify key stakeholder(s) to ensure ownership and a clear chain of command. Further, the roles and responsibilities of all stakeholders in implementing MSDI needs to be clarified and documented, with clear protocols for engagement (see Chapter 4 for further context).

Preparing a **stakeholder map** can help understand the local institutional landscape. It helps identify the various stakeholders while also serving as a reference document to invite participants for a series of discussions as the MSDI roadmap development takes shape. Arriving at this map can be fairly straightforward (either by **brainstorming** with the agency in charge of MSDI implementation or conducting a **series of discussions** with key stakeholders), using the city's overall current organization chart as the base and overlaying personnel who can be involved in the MSDI journey. In this process, **it is important to identify the function of agencies and their representatives within the city, the power dynamics that may exist between them, office bearers of these agencies and individuals (agency lead, middle management officer or technical staff) who have the potential to positively or negatively influence the data-driven planning journey**. The role of private sector actors and the general public must also be documented so that they can be involved in MSDI implementation in the longer-term horizon.

MSDI LEAD AND CO-LEAD AGENCIES

The lead agency is one that has the authority/ responsibility to lead/coordinate other agencies in the MSDI roadmap development and implementation process. Co-leads or key coordinating agencies will be required to support the lead agency across various dimensions including technical aspects such as ICT components. These co-leads will also play an important role in reinforcing the need and urgency

FIGURE 5

Illustration demonstrating the identification of lead and co-lead agencies based on their level of influence on MSDI implementation

Supporting Agencies
General interest

Co-lead
Directly affected, high interest, has the main function to support MSDI

MSDI lead
High influencer

of implementing MSDI and facilitate the engagement process. Knowing the city's overall organizational structure (which may vary greatly from one context to another), plays a role in identifying the lead and co-lead agencies[8] along with a closer look at the stakeholder list prepared. The most important groups based on their interest and influence in steering MSDI will emerge as the top two agencies for implementation. Once the roles are identified, clear communication channels must be established. An early engagement with these key stakeholder agencies is also critical to underscore the importance of evidence-based urban planning and the role of MSDI in enabling it.

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8   For example, in the Indonesian context, coordination across municipal departments are handled by a central planning agency (BAPPEDA). However, in performing its spatial planning function, BAPPEDA is typically assisted by a Spatial Planning agency, which may sometimes also double up as the department of Public Works. Data management and implementations of new technology, on the other hand, are typically handled by the Agency of Communications and Informatics. Given the multi-sectoral and collaborative nature of an MSDI, it is important that MSDI implementation efforts are done in alignment with this existing organizational structure.

IDENTIFY DEPARTMENTAL CHAMPIONS AS STAKEHOLDERS

Every agency in the city, even if not a data producer or custodian, benefits from operationalizing MSDI as a data user. Therefore, **it is critical to identify "champions" from each agency and involve them from initial stages of promoting the MSDI concept across the city government.** These champions can also be invited as participants to MSDI workshops and be working group members, as relevant (see Chapter 4 for further context on Champions).

BOX 3: DATA CHAMPIONS

A Data Champion, Data Champ in short, is someone who serves as an agency's main point of contact for other agency inquiries on data-related matters, be it verifications, updates, or access to restricted datasets. This includes being a focal point of the agency to the one that houses the central database, ensuring data linked from the agency to the central database is correct, accurate, and updated. Conversely, the champion is also responsible for keeping track of other datasets that exist in the city, which the agency can tap into to enhance their service delivery.

Within the agency, the champion's role is to advise on all aspects pertaining to the lifecycle of datasets including, production and collation of data, data processing, data dissemination, proper data management techniques, methods of analysis using data, and promoting the proliferation of this knowledge within his/her department. Given these core external and internal functions, the existence of Data Champions within an MSDI-implementing organization becomes an integral component.

Further information on Data Champions can be obtained from the spatial information policies of the City of Johannesburg, mandated by The City of Johannesburg's Corporate Geo Informatics Directorate. Other examples on the introduction of this role can also be found in both academic literature (i.e.Cambridge and Delft University of Technology), as well as within the public sector (i.e.New Zealand and the UK).

CONSENSUS BUILDING THROUGH A DIAGNOSTIC REVIEW:

This step is an important one for consensus building and the co-creation of an MSDI Roadmap. As described in later chapters,the diagnostic tools are not just assessment tools but serves as the foundation to develop the Institutional Arrangements pillar. It comprises two types of diagnostics. The first type is a lighter, **rapid assessment** that is intended to develop a common perception across city agencies on the current status of MSDI enabling factors **(Rapid MSDI Readiness Assessment)**. The rapid assessment also highlights socio-economic sectors that would need to be prioritized from a geospatial development perspective **(Geospatial Prioritization Survey)**. In addition to this, both surveys serve as tools to mobilize buy-in from senior officials in charge of driving the data-driven planning agenda. The second type is a **technical assessment**, entailing an in-depth review of current state across the Institutional Arrangements, People, Data, Systems (IPDS) dimensions **(Deep-Dive MSDI Capacity Assessment)**. It is aimed at gathering detailed information on the city's baseline MSDI capacity, such as the number of staff trained in Geographic Information Systems (GIS), their educational background, types of geospatial software utilized, etc.

RAPID ASSESSMENTS:

This comprises two assessments, namely the Rapid MSDI Readiness Assessment and Geospatial Prioritization Survey for City Development Goals Survey. The former should be conducted first to develop the city's MSDI Readiness Index followed by the latter. These surveys could happen back to back in two consecutive days, if city agency representatives are available.

1. RAPID MSDI READINESS ASSESSMENT

This rapid assessment enables decision-makers to develop a common understanding of the current status of the city's MSDI readiness across the Institutional Arrangements, People, Data, Systems (IPDS) enabling components. The survey is targeted at mid to high-level officials and includes questions, among others, on the existence of funding to support geospatial development efforts as well as policies to regulate dissemination and usage of geospatial data, and the reliability of internet connections. The results will pave the way for city officials to determine their MSDI priorities, and for agency staff to obtain buy-in on the recommendations they later develop in the MSDI roadmap.

This assessment utilizes a simple five point Likert-type scale to rate the responses of city officials from 'Very Low' to 'Very High' for each of the questions under the MSDI-IPDS enablers. For the purpose of calculating a quantitative score for each of the enablers, these responses from individual participants are then replaced with pre-determined assigned numeric values (ranging from zero for very low to one for very high) and a final score (an average of all values across all participants) is computed. This allows the MSDI delivery team to assess the result of this analysis using a simple methodology.

The readiness score of a framework pillar e.g., Institutional Arrangements) is then calculated by averaging the score of individual enablers that make up the pillar.

Finally, the city's overall **MSDI Readiness Index** is obtained by averaging the values across all framework pillars.

The simplicity of this method means that this assessment can be administered and evaluated very quickly. The results can be presented to the participants within the same day, and initial discussions on preliminary steps for MSDI implementation can commence.

The complete set of survey questions and details of the rating scale can be found in Annex 4.

BOX 4: EXAMPLE USE CASE OF THE RAPID MSDI READINESS ASSESSMENT

The Rapid MSDI Readiness Assessment provides common ground for city officials to reflect on the status of IPDS framework pillars and its enabling components. This then allows the identification of a broad direction and strategy to address the primary obstacles faced in MSDI development. Some examples of preliminary recommendations that city officials may come up with, in response to the results of the assessment are illustrated below:

. . . .

Scenario 1. Low SDI readiness index caused by a low Institutional Arrangement score (especially with respect to funding)

- Link the MSDI to other city programs where geospatial management could be crucial (e.g., Information Society, disaster management, land administration).
- Conduct cost/benefit analysis to emphasize the benefits of MSDI to convince senior management about the importance of investing in geospatial data infrastructure.
- Orient the data and system strategy towards Open Source in order to obtain free access to the geospatial standards necessary to build an SDI.
- Explore alternative funding models for emerging nations (United Nations Economic Commission for Africa, UNECA, 2004).

. . . .

Scenario 2. Low SDI readiness index caused by a low People score

- Encourage capacity building projects related to geospatial data use.
- Create city strategic by identifying spatial data champion from every agency.
- Institutionalize SDI initiatives in city annual work plans to enable city staff to learn about and use spatial data in their routine activities.

. . . .

Scenario 3. Low SDI readiness index caused by a low Data score

- Encourage the private sector and academia to work on spatial data to link with city programs where this information could be useful.
- Encourage international capacity building projects related to cartography and geodetic industry.

. . . .

Scenario 4. Low SDI readiness index caused by a low System score

- Find alternative approaches to undertake MSDI tailored to the actual conditions of the country (for instance, centralized servers to concentrate the technological power and maximize the sharing of geospatial data and its performance)
- Take advantage of the Open Source products distributed freely in the market place.

2. GEOSPATIAL PRIORITIZATION SURVEY FOR CITY DEVELOPMENT GOALS (IN SHORT GEOSPATIAL PRIORITIZATION SURVEY)

The MSDI Roadmap will be most effective when its action plan is aligned with the city's sectoral developmental priorities and goals. **The Geospatial Prioritization Survey is a quick benchmarking exercise with the city's decision makers to establish a broad consensus on sectors that would need to be prioritized from a geospatial development perspective.**

The survey first carries out a rapid assessment of the relative importance of each sector with respect to other sectors in the context of the city's overall development priorities and vision. It also maps out the broad prioritization needs for geospatial data by sector (relative to other sectors), along with an early understanding of the policy and resource gaps pertaining to geospatial data utilization. The findings inform recommendations for monitoring MSDI progress and enabling its effectiveness by aligning MSDI with the city's priorities in the short and medium term.

The survey sectors are adapted from the International Standards Organization (ISO) 37120 standards, which recommend standardized indicators for measuring the performance of city services and their impact on quality of life. These urban services are critical for an integrated approach to sustainable development and resilience.

The sectors used in the survey are described on the next page.

Based on the responses from participants and the relative importance assigned to the sectors in this exercise, they are categorized as first, second and third priority sectors. This classification allows city officials to reach a consensus on the sectors that represent a priority concern for their city, and subsequently align their MSDI implementation efforts with the programs and activities of these priority sectors. This alignment is important to ensure that activities pertaining to MSDI implementation will also be relevant for the city's priority sectors, thereby paving way for MSDI sustainability.

Given the importance of aligning MSDI with city priorities, the MSDI delivery team would benefit from discussing and validating the

SECTOR | DESCRIPTION

SECTOR	DESCRIPTION
Economy	*Economic health and manpower, such as employment rate, poverty rate.*
Education	*Educational opportunities, such as student enrolment, student/teacher ratio, completion of primary and secondary education, prevalence of higher education degrees.*
Energy	*Efficiency of electricity production and consumption, such as electrical energy use per capita, use of renewable sources.*
Environment	*Environmental quality and biodiversity conservation, such as atmospheric concentrations of Particulate Matter, noise pollution, health of native species.*
Finance	*Financial management, such as debt service ratio, capital spending, own-source revenue as a percentage of total revenues.*
Fire & Emergency Response	*Provision of fire and emergency services, such as prevalence of firefighters, response time for emergency services.*
Health	*Provision of healthcare services and general health of the population, such as access to healthcare services, average life expectancy, infant mortality rate.*
Safety	*Law enforcement, such as crime rate, prevalence of police officers, response time from police department.*
Shelter	*Provision of housing, such as access to formal housing, registration of legal titles for households.*
Solid Waste	*Solid waste collection, such as access to solid waste collection services, recycling rate.*
Telecommunication & innovation	*Telecommunications services and connectivity, such as access to Internet and cell-phone connections.*
Transportation	*Provision of transportation services, such as rail network, car ownership, availability of bicycle lanes.*
Urban Planning	*Urban planning, such as land use planning, prevalence of green areas.*
Water & Sanitation	*Wastewater collection, water supply service and sanitation facilities such as sewer system, access to potable water, wastewater treatment.*

findings with the lead and co-lead agencies for MSDI implementation in the city, prior to integrating them into the roadmap. Ideally, validation of the city priorities identified from this assessment should be performed by the MSDI lead agency that possesses a deep and comprehensive understanding of the issues that city will face during MSDI implementation.

The complete set of survey questions of this survey can be found in Annex 4.

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FIGURE 6

Sample of Prioritized Sectors (Indonesian Context- City of Balikpapan) for Geospatial Development

First Priority
Sectors with strategic value for the city to pursue & where geospatial is a critical enabler to support its growth

Urban Planning

Second Priority
Sectors that are of value for the city to pursue & where there are opportunities for the greater use of geospatial information

Disaster Response

Third Priority
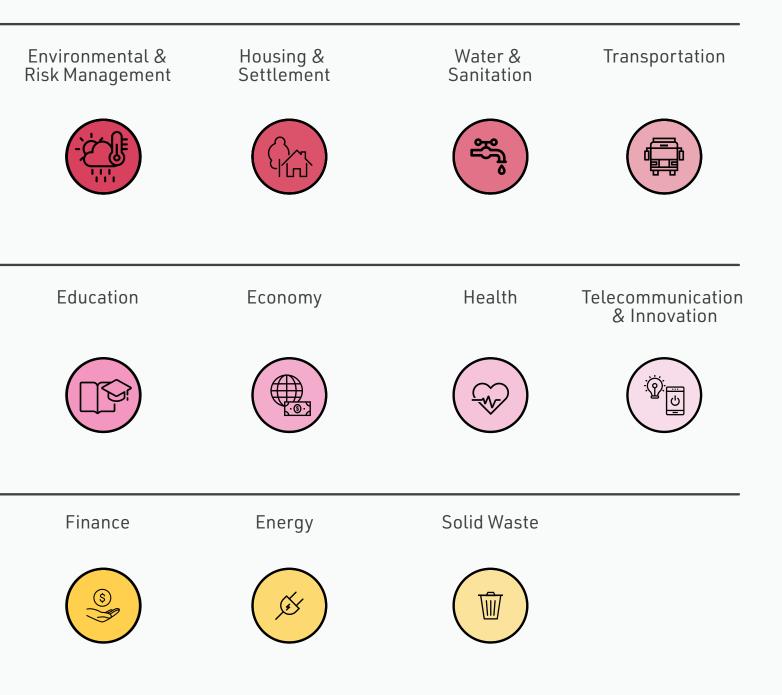Sectors that have opportunities in the longer term for the use of geospatial

Safety

Environmental & Risk Management

Housing & Settlement

Water & Sanitation

Transportation

Education

Economy

Health
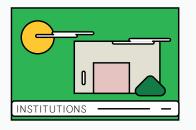
Telecommunication & Innovation

Finance

Energy

Solid Waste

TECHNICAL ASSESSMENT:

The timing of this assessment can vary depending upon the nature and extent of the MSDI delivery team's engagement with the city. If the engagement with senior officials is progressing in a positive direction, this assessment can occur concurrently with the rapid assessments to establish the technical requirements that need to be factored into the roadmap development. In other cases, it may be beneficial to first obtain the results of the rapid assessments and garner the buy-in of senior officials before embarking on the deep-dive assessment.

DEEP-DIVE MSDI CAPACITY ASSESSMENT
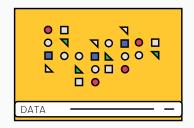
In order to develop meaningful recommendations for the MSDI roadmap, it is important that the MSDI delivery team possess a deep and objective understanding of the city's baseline capacity across the four IPDS framework pillars. Given the detailed and often technical nature of questions in this survey, contrary to the rapid surveys that are meant for decision makers, the Deep-Dive MSDI Capacity Assessment questionnaire should ideally be addressed to city's mid-level technical staff. The outcomes can be used to inform the formulation of strategies to implement MSDI. In accordance with this approach, the Deep-Dive MSDI Capacity Assessments can be broadly divided into four sections:

INSTITUTIONS

PEOPLE
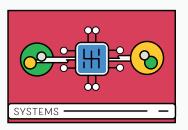
INSTITUTIONAL ARRANGEMENTS CAPACITY ASSESSMENT

PEOPLE CAPACITY ASSESSMENT
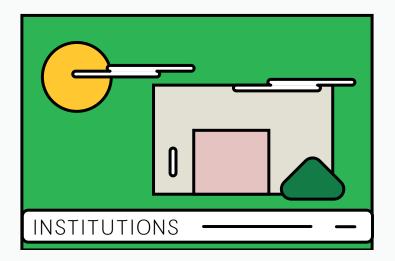
DATA CAPACITY ASSESSMENT

SYSTEM CAPACITY ASSESSMENT

Given the breadth and depth of questions that form the sections of this assessment, it is important to have two sets of this assessment questionnaire, each tailored for and administered to a different set of stakeholders. The first set of questionnaires should be targeted at key MSDI stakeholder agencies (method to identify these agencies is described in the preceding section). Considering the central role these key agencies play throughout the MSDI implementation process, their questionnaires will be more detailed, compared to the second set of questionnaires. The second set of questionnaires, aimed at other municipal agencies that may partake in the MSDI implementation efforts despite not being a key stakeholder agency, are more generic in nature, and can focus more on the overall geospatial capacity of these agencies, e.g. availability of staff trained in GIS, geospatial data availability etc. (see Annex 4 for the full set of questionnaires)

The information gathered from the Deep-Dive MSDI Assessment can inform the MSDI delivery team on the necessary next steps to implement MSDI. For example, the Data Inventory questionnaire, when completed in conjunction with the Fundamental Data Set (FDS) Assessment Tool can inform the team of the city's status in terms of their FDS availability and gaps. Teams can develop a recommendation to collect a particular dataset that aligns with the identified priority sectors (from the Geospatial Prioritization Survey) as a priority action to be executed immediately.

INSTITUTIONS
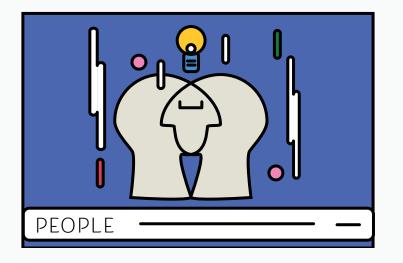
INSTITUTIONAL ARRANGEMENTS: CAPACITY ASSESSMENT

Successful MSDI implementation often hinges on the development of appropriate regulatory protocols for spatial data management as well as a clear organizational structure (with well-defined roles and responsibilities) to enable execution.

An assessment of the current state of these two aspects is necessary, so that city officials and the MSDI delivery team can obtain a clear understanding of the existing environment in which the MSDI initiatives are going to be implemented.

Sample questions:

1. *What is the interaction / linkage between the national government and the city government with respect to geospatial data?*

2. *Are there currently any legal restrictions to data sharing?*

3. *How can cities improve inter-agency data sharing?*

4. *Does the agency have an open data policy? If yes, what data does it apply to?*

5. *Does your municipality / agency have GIS guidelines, strategic plan or roadmap for geospatial information management?*

PEOPLE
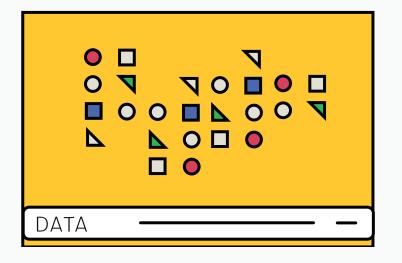
PEOPLE: CAPACITY ASSESSMENT

Developing and completing a human resource assessment helps develop an inventory of personnel that possess relevant geospatial skills to contribute to MSDI implementation. As such, information gathered from this assessment is representative of the baseline geospatial capacity of the agencies. This can subsequently be used to evaluate the city's geospatial manpower and skill gaps, from which training needs can be identified. Further, in the medium to long-term, this assessment will also help inform the development of a Competency Framework and Strategic Workforce Planning that is required to successfully implement the People pillar of the IPDS framework.

Sample questions:

1. *What is the level of awareness of and support for geospatial implementation in your agency?*

2. *How many personnel have a formal education background in Geography / Surveying / Geographic Information Systems (GIS) / Cartography / Urban Planning*

3. *How many permanent data / GIS specialists do you have in your department?*

4. *Describe the level of GIS skills and experience possessed by your personnel in general (basic/intermediate/advanced)?*

5. *Are there any capacity building initiatives for data and/or GIS analysis in the agency?*

6. *Please identify any additional skills that agency personnel may require to aid in data management*

DATA: CAPACITY ASSESSMENT

The Data pillar is a critical one in the IPDS framework. Therefore, it is important that an MSDI assessment includes an evaluation of the current state of data quality and availability in the city, particularly for geospatial data. This activity also allows cities to take stock of geospatial data. Given the tendency of sectoral agencies to operate in silos, and the fact that cities often procure the services of external consultants to perform their data collection, it is possible that city officials do not possess a comprehensive understanding of the geospatial data available in their city.
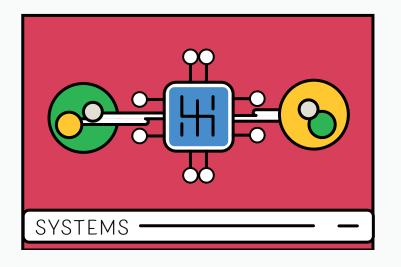
In addition, new geospatial datasets are often produced by referencing existing geospatial data. Therefore, the availability of geospatial data (especially reference geospatial data i.e., FDS) becomes an important component that determines the ability to produce new geospatial datasets.

Sample questions:

1. *Give a brief description of the data that your agency possess.*

2. *How do you store or manage data you work with? What medium is the dataset stored on at your agency e.g., cloud, server, workstation, external hard drive, CD, DVD, paper etc.?*

3. *Is the data stored as a database or a file? Is the data stored in separate files (.xls, .shp, .dwg, .tab) or is it in a database (Oracle, PostgreSQL, MySQL etc.)?*

4. *How do agencies request data from each other? Do Do you have to login to a portal? Can you access the data through a network from a server / another workstation or do you need to approach someone to get a paper map / copy on CD / DVD?*

5. *How do you normally use the dataset? For spatial planning, master planning, transport planning etc.?*

Thus, the Data Capacity Assessment seeks to accomplish both the objectives outlined in the previous paragraphs, by undertaking two assessments:

- **Data inventory assessment**: the questionnaire asks agency representatives to list out all data currently available in their agency. It includes questions that are designed to evaluate the nature of the data, e.g. whether it is spatial or non-spatial, its format, and what it is currently used for, among others.

- **FDS Assessment**: this assessment is aimed at identifying the city's FDS gaps. The assessment toolkit itself comes as a simple string-matching algorithm, written in the R language, that teams can use to quickly cross reference the result of the data inventory questionnaire against a list of FDS that national governments may have established. At the end of the assessment, the algorithm generates a plot that informs cities of their existing level of FDS availability and gaps, expressed as a percentage of the FDS that the city has, calculated against the full list of FDS that is relevant for the implementation context.

6. What are the difficulties you face with respect to using this dataset within your agency? Some examples include: lack of licenses, poor/slow internet connection, lack of hard disk space, lack of memory, antiquated computers, etc.

SYSTEMS

SYSTEMS: CAPACITY ASSESSMENT

One of the biggest challenges in developing a robust MSDI is providing an appropriate technological environment, to support data sharing and geospatial data use. The components to be considered in the 'Systems' pillar of an MSDI can be further broken down into four components which include: the geospatial software being used, hardware, network capacities and the geoportal. Given this, the 'Systems' Capacity Assessment section is also structured according to these sub-components.

SOFTWARE ASSESSMENT

The first section of this assessment aims to obtain an inventory of all the software used by the different agencies (including program versions, number of licenses etc.) This stock take helps the MSDI delivery team understand the current state and develop a method to standardize the conversion process of different datasets (produced by different software), so that they

Sample questions:

1. *In which programs is data produced?*

2. *In which programs is data processed?*

3. *In which program is data analyzed?Does the software / applications used meet your needs?*

4. *Are there any customized software/applications that are used for processes in the agency?*

5. *If the application was not developed in-house, is there internal and external documentation of the application and information on who developed it and how they can be contacted?*

can be seamlessly used by various agencies for their planning purposes and uploaded onto the geoportal of the city. A software upgrading plan to ensure all agencies are using the most up-to-date versions could also be developed based on the findings of this assessment.

When developing a recommendation based on the findings of this assessment, it is important to note that the price of upgrading software could be prohibitive for some cities and agencies. Based on the needs and available budget, it can be beneficial to explore the use of open-source solutions for software. For example, using Quantum GIS and Apache OpenOffice can drastically reduce costs. However, this benefit must be weighed in relation to lack of technical support and at times, limited functionality of such open-source software.

Beyond the usual desktop-based software, many agencies develop their own customized applications based on work flows and needs. For example, a licensing agency may have a web application to input license requests online. Integrating such programs into the MSDI is challenging, as these applications typically restructure datasets to a format that complies with the legal requirements of a particular purpose, rather than restructuring them to a consistent Tidy Data format[9] that is more suitable for wider use. Several key aspects of the applications need to be thoroughly understood including:

....

9   Tidy data sets are data whose values are organized such that each variable is a column, and each observation (e.g., individuals, geographic features, or cases) is a row, making it easy to manipulate, model, and visualize

Upon completion of this review, a standardized conversion procedure of the inputs/ outputs of these applications can then be developed to ease the process of integrating datasets. It may also inform agencies of possible overlapping functionalities which agencies could then consider when developing a streamlining plan.

HARDWARE ASSESSMENT

Hardware issues can make or break the functioning of MSDI, as workstations and servers must be able to handle data transfer, processing and data storage needs to support data sharing. In assessing the 'Systems' hardware component, it is important to not only catalogue available hardware, but also understand how it is being used currently.

Two basic types of hardware that need to be assessed for purposes of implementing an MSDI are workstations (computers) and servers. Information on basic specifications of the computer is important to understand whether workstations will be compatible with software packages to be used. A sound understanding of the server capacity, quality of connections, and network traffic is also equally critical, to see if the existing network environment will be able to handle the increasing data traffic from increased data transfer and sharing activities.

Sample questions:

1. *Do the workstations currently used in your agency meet your needs?*

2. *How much does your agency typically budget for new workstations per year?*

3. *Is data backed-up? If so, how frequently and where is the back-up stored?*

4. *Does your agency have access to, or own, Global Positioning System (GPS) equipment?*

5. *Are servers local or cloud-based?*

6. *Are there any regulations that determine where servers are to be housed and managed?*

7. *Who conducts maintenance on servers?*

The baseline information on existing hardware collected through this survey can inform recommendations for the MSDI's Systems pillar. While assessing the hardware, it is also crucial to note how different agencies are managing data within the current system. Unless there are strong regulations already in place, each agency is likely to manage data in different ways, based on the available hardware and their day-to-day needs.

NETWORK ASSESSMENT

Data integration and data sharing across agencies can be efficiently accomplished only if the government network has appropriate internet bandwidth and security features to ensure the security of data and file sharing activity that MSDI promotes. If data cannot be quickly uploaded and downloaded, users will be incentivized to store data locally instead of networked servers, which is not ideal for purposes of wider data sharing and utilization.

GEOPORTAL ASSESSMENT

The development of a geoportal is critical to operationalize data sharing and management policies established under the Institutional Arrangements component of MSDI. A geoportal can serve as a one-stop platform for accessing available city geospatial data and services, therefore providing a common basis for individual agencies' applications to connect to, especially if these applications are also offering some

Sample questions:

1. *What is the available bandwidth and speed of the internet connection that you are using?*

2. *Who maintains the intranet/ internet connections (internal IT vs. consultant/outside provider)?*

3. *What network security measures are in place and do they prevent users from performing certain tasks?*

Sample questions:

1. *Does a consolidated platform for finding geospatial data and services exist?*

2. *If yes, continue question below. If no, please jump to question no. 8*
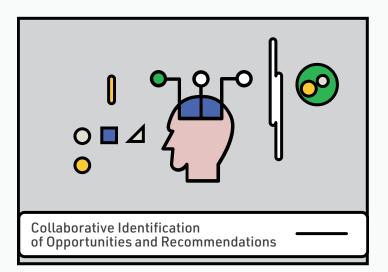
form of geospatial services (i.e. flood mapping, weather monitoring, location services, or others) and data. A geoportal has the potential to promote synergies among varied platforms across agencies and enable efficient sharing and use of spatial data.

However, despite its potential, a geoportal can only function optimally if the regulatory, people, hardware, software, and network systems that support it operate efficiently. For example, there is no value in having a geoportal, if the data regulation in a particular organization forbids the dissemination of geospatial data, or if agencies are not aware that such a portal exists in the first place. In some other cases in the developing world, cities may not have a geoportal yet, or even know what a geoportal is.

As such, the questions to assess the condition of a geoportal may span beyond the technicalities associated with the geoportal itself, to also include the governance aspects that may affect the required functionalities of the geoportal (a regulation on data access would have implications on the data visibility functionality of the geoportal).

3. *Is the portal accessible to the public?*

4. *Is there a means for other applications/ portals to connect to this portal? Please describe briefly.*

5. *Are there different levels of access to information in the portal, based on the types of users (i.e. public, government officials, admins etc.)?*

6. *Is there a process in place to ensure that data information is uploaded to this portal? Please describe briefly.*

7. *What is the approximate monthly user traffic for this portal?*

8. *Do you think a geoportal can facilitate collaboration among agencies? What needs to be in place to achieve this?*

9. *Which GIS data sets would you like to add to Geoportal first? Why?*

10. *Which agency would benefit the most if they start using the geoportal?*

**Collaborative Identification
of Opportunities and Recommendations**

2

STEP TWO:
COLLABORATIVE IDENTIFICATION OF OPPORTUNITIES AND RECOMMENDATIONS
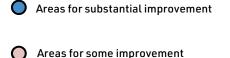
This step involves identifying opportunities and homing in on key recommendations for MSDI implementation, in order to arrive at a roadmap and action plan. Many of the processes involved this step require extensive deliberations among the MSDI delivery team and key stakeholders, and thereafter with other stakeholders.

Collaborative approach between agencies refers to a joint problem-solving approach that is undertaken by city agencies in discussing challenges, opportunities, and solutions to a problem. Discussions are intended to prompt participants to share their understanding of a problem and develop a consensus on how the problem can be addressed.
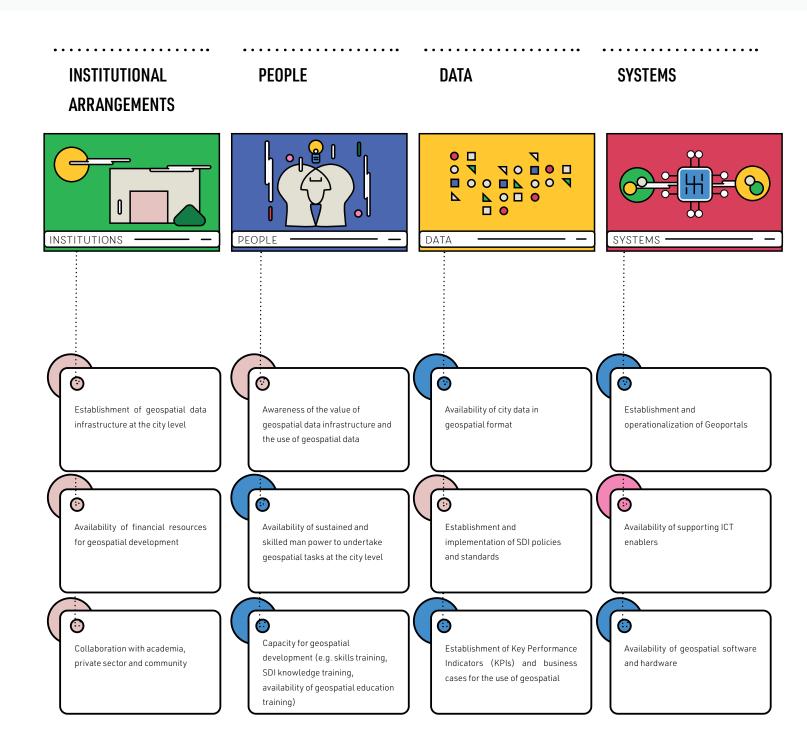
CHARACTERIZE THE CURRENT STATE OF IPDS ENABLERS

An IPDS enabler can be understood as a component (regulation, staff availability and capacity, geospatial data availability and quality, supporting infrastructure etc.) that would allow cities to successfully operationalize the individual IPDS pillars of MSDI, which will subsequently contribute to the operationalization of the MSDI. The diagnostics performed in the previous step allowed the MSDI delivery team and officials to understand the baseline state of these enablers. Therefore, building on the previous diagnostics that the team conducted in the first step, the team can then synthesize a summary of the city's current state across the IPDS enablers.

Note that the process of synthesizing or characterizing the current state of IPDS enablers is a collaborative process that should be jointly done by the MSDI delivery team and its city government counterparts. At this point in the implementation step, the MSDI delivery team would have established a strong relationship with city officials from lead and co-lead agencies, given the engagement with both high-level

Areas for substantial improvement

Areas for some improvement

Areas for strengthening

INSTITUTIONAL ARRANGEMENTS

PEOPLE

DATA

SYSTEMS

INSTITUTIONS

PEOPLE

DATA

SYSTEMS

Establishment of geospatial data infrastructure at the city level

Awareness of the value of geospatial data infrastructure and the use of geospatial data

Availability of city data in geospatial format

Establishment and operationalization of Geoportals

Availability of financial resources for geospatial development

Availability of sustained and skilled man power to undertake geospatial tasks at the city level

Establishment and implementation of SDI policies and standards

Availability of supporting ICT enablers

Collaboration with academia, private sector and community

Capacity for geospatial development (e.g. skills training, SDI knowledge training, availability of geospatial education training)

Establishment of Key Performance Indicators (KPIs) and business cases for the use of geospatial

Availability of geospatial software and hardware

officials (via the Rapid MSDI Readiness Assessment and Geospatial Prioritization Survey), and technical staff (via the Deep Dive MSDI Capacity Assessment). Based on these assessments, teams can form a preliminary synthesis of the IPDS pillars baseline condition in the city, for the purpose of framing the discussion regarding these key IPDS pillars with key stakeholders.

Once all the key characteristics of the IPDS enablers have been collaboratively discussed with the city agencies, the next step is to categorize them based on their level of development as below:

Areas for substantial improvement: critical areas in a nascent stage of development where there are many untapped opportunities for the city that need to be realized in order to implement MSDI.

Areas for some improvement: important areas that have demonstrated some early-stage efforts but require further solutions and improvements in order to implement MSDI.

Areas for strengthening: areas which can be further strengthened downstream for the sustainability of the city's MSDI.

This may later be deliberated and refined further with other agencies as relevant. The categorization exercise provides an overview of the present situation for senior officials. A sample result of the exercise (in the Indonesian context) is shown in Figure 7 .

IDENTIFY A LIST OF TEN OPPORTUNITIES

Based on the result of the categorization exercise, a preliminary list of proposed interventions across all these areas can be developed. For example, in Figure 7, 'Capacity for geospatial development' has been identified as an area that requires substantial improvement. In response to the identified state of development for this enabler, the MSDI delivery team may suggest 'Targeted geospatial training' as an opportunity to address this concern.

Much like in the synthesis step, further discussions with key stakeholders should also be conducted to ensure the validity of the recommendations/ opportunities to be developed in this section. This discussion is particularly important for several key line agencies, who will likely play a significant role throughout the MSDI implementation stages, such as the MSDI lead and co-lead agencies. Thus, collaboration and consensus building with city governments should be prioritized at every step of the roadmap development.

Discussions with counterparts may give rise to numerous opportunities and challenges to implement MSDI. However, given that cities often have limited resources and competing demands, it is imperative to streamline opportunities to a maximum of ten in number. It is advisable to keep in mind the intersection of one opportunity with other related opportunities to enable effective shortlisting.

A sample list of opportunities (and the ten shortlisted) is illustrated in the 'Opportunities' column in the table (See Figure 8). The opportunities are translated from the points listed in the 'MSDI Enablers' column which are taken from Figure 7.

In thinking about the identified enablers and corresponding opportunities with this framework, cities and the MSDI delivery team can begin to streamline the numerous opportunities and challenges that they may have initially formed with their counterparts. The framework also imposes a structure in which opportunities can be organized into relevant IPDS categories.

IPDS FRAMEWORK PILLAR	MSDI ENABLERS	OPPORTUNITIES
INSTITUTIONAL ARRANGEMENTS	Establishment of geospatial data infrastructure at the city level	**1. Develop and institutionalize an MSDI working model**
	Availability of financial resources for geospatial development	*Funding plan may be included and institutionalized in the MSDI working model (this intersects with #1)*
	Collaboration with academia, private sector and communities	**2. Develop a model for collaboration with academia, private sector and communities**
PEOPLE	Awareness of the value of geospatial data infrastructure, and the use of geospatial data	**3. Create a taskforce to convene experts across agencies to solve common pressing problems**
	Availability of sustained and skilled geospatial manpower to undertake geospatial tasks	**4. Develop a competency framework of geospatial skills**
	Capacity for geospatial development	**5. Administer targeted geospatial courses that address immediate geospatial needs from city officials**

FIGURE 8

Sample List of Opportunities

IPDS FRAMEWORK PILLAR	MSDI ENABLERS	OPPORTUNITIES
DATA	Availability of city data in geospatial format	**6. Formulate a data sharing and request methodology to fill gaps in data availability**
	Establishment and implementation of SDI policies and standards	**7. Institutionalize a set of FDS that focus on the city's short-term development needs**
	Establishment of Key Performance Indicators (KPIs) and business cases for the use of geospatial data	**8. Establish outcome-based Key Performance Indicators (KPIs) focusing on specific urban issues**
SYSTEMS	Establishment and operationalization of a geoportal	**9. Develop an clearinghouse for the government** **10. Conceptualize public-facing geoportals to support citizen e-services**
	Availability of supporting ICT enablers	*Partially addressed by #1 and #2 – budgets and purchasing of equipment may be included with an SDI policy, or with a city's municipal budgeting process*
	Availability of geospatial software and hardware	*Partially addressed by #1 and #6 – Open source geospatial software such as QGIS can be introduced as part of targeted geospatial capacity building*

PLOT OPPORTUNITIES BASED ON IMPACT AND EASE OF IMPLEMENTATION

Following identification, the **ten opportunities can then be prioritized according to two strategic criteria: (a) the impact of the specific opportunity on the city, and (b) whether the specific opportunity can be easily implemented**. Plotting the list of opportunities according to these two criteria is key in initiating consensus building among agency officials, as they provide officials with a base to visually compare the importance (impact), and ease of implementation of the opportunities, in relative terms. **In CPL's experience, this visual plot of opportunities to operationalize an MSDI can enhance the debate and dialog that is necessary in the identification of key recommendations for the roadmap.**

This process is integral to taking steps to operationalize MSDI, especially developing appropriate MSDI regulations. It is also a critical step to focus efforts on key recommendations that are achievable within a five-year horizon. This ensures the city's limited resources are spent optimally on 'what matters the most'. As such, the guiding questions to prioritize the opportunities are:

IMPACT FOR CITY:

- Will the city benefit from it?

- Does it address issues flagged in the diagnostic review?

Impact is '**beneficial**' if it represents **some** opportunity for MSDI growth and has the potential to effect sector-specific changes. Impact is '**strategic**' if it represents **substantial** opportunity for MSDI growth and has the potential to effect sector-specific changes.
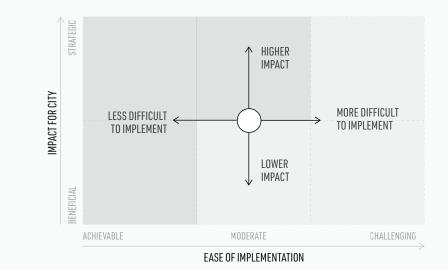
EASE OF IMPLEMENTATION:

- Are significant changes in process required?

- Are significant investments required?

- Are there existing plans?

Ease of implementation can range from 'achievable' (quick wins) to 'moderate' (requires some concerted effort but can be implemented) to 'challenging' (difficult to implement).

While the initial plotting of ten opportunities can be performed internally by the MSDI delivery team, the positioning of these opportunities within the plot should also be consulted with client counterparts. During these consultations, it is very likely that opportunities may be deemed too difficult to implement (and should therefore be moved further to the right in the plot), or to be less impactful than the team had originally perceived it to be (not in line with the city's broad needs and should be moved further down). Such discussions between the MSDI delivery team and lead/co-lead agencies need to happen for the opportunities to reflect the actual conditions of MSDI enablers, as perceived by the counterpart. The following is an example of how opportunities can be plotted, based on impact on the city and ease of implementation:

FIGURE 9

Developing a Visual Plot of Opportunities

BOX 5– OPPORTUNITY PLOTTING WITH THE CITY OF BALIKPAPAN FOR 'TASKFORCE DEVELOPMENT'

Based on CPL's previous experience in other cities in Indonesia, introducing recommendations that involved organizational interventions (e.g., creation of a working group, or creation of a Geocommunity (see Chapter 4 for more details) or a geospatial taskforce were found to be heavily dependent on the relationship dynamics across city agencies. Thus, CPL had originally plotted the 'Development of a Geocommunity' opportunity as more difficult to implement for the City of Balikpapan.

During the validation meeting with key stakeholder agencies in the City of Balikpapan, most of the plotting was found to be in line with the client counterparts. However, they highlighted that the relationship dynamics across agencies in the city is generally positive and that should not be a concern when plotting opportunities related to organizational interventions. Thus, after discussion the 'Development of a Geocommunity' was moved across the graph to indicate easier implementation and was actioned on shortly thereafter.

DISTILLING THREE PRIORITY RECOMMENDATIONS AND CLUSTERING OF TEN RECOMMENDATIONS

Three key opportunities are then selected based on what can be implemented in the short-term ("achievable and moderate" in its ease of implementation and "strategic" in its impact). This is particularly important as the three selected opportunities represent immediate aspects that cities can act on. While a preliminary shortlisting can be done by the MSDI delivery team, it is imperative that the team consults the lead/co-lead agencies to ensure alignment and validation. The MSDI delivery team's role is primarily to be the facilitator that urges cities to think about the challenges and opportunities pertaining to MSDI implementation, as well as encouraging them to take action to implement it.

This process should then be followed up by a matching process between the selected three key opportunities, and the remaining seven opportunities that are part of the original ten, based on their relevance. In clustering the opportunities in this manner, the three identified opportunities are translated into recommendations, which will serve as the lead interventions that contribute to the achievement of the other seven opportunities. Further sub-activities should also be derived, based around the three key recommendations that has been identified in this process.

LIST OF IDENTIFIED OPPORTUNITIES

1. **Develop and institutionalize a working MSDI model**
2. Develop a model for collaboration with the academia, priavte sector and communities
3. **Create a taskforce to convene experts across agencies to solve common pressing problems**
4. Develop a competency framework of geospatial skills
5. Administer targeted geospatial courses that address immediate geospatial needs from city officials
6. Formulate a data sharing and request methodology to fill gaps in data availability
7. Institutionalize a set of FDS that focus on the city's short-term development needs
8. Establish outcome-based Key Performance Indicators (KPIs) focusing on specific urban issues
9. **Develop an clearinghouse for the government**
10. Conceptualize public-facing geoportals to support citizen e-services

FIGURE 10
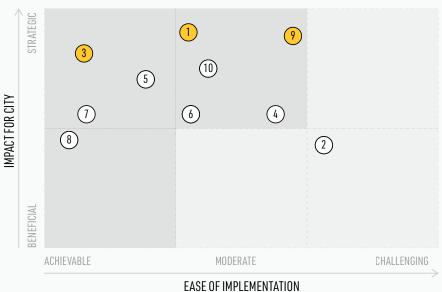
Sample Plotting of Opportunities (Indonesian Context) to Prioritized Recommendations
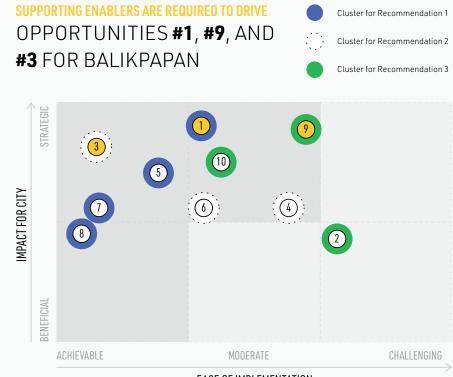
BALIKPAPAN SHOULD FOCUS ON:

IDENTIFIED OPPORTUNITIES #1, #9, AND #3

○ Opportunity that should be developed as a recommendation

○ Supporting opportunity that should be tackled incrementally
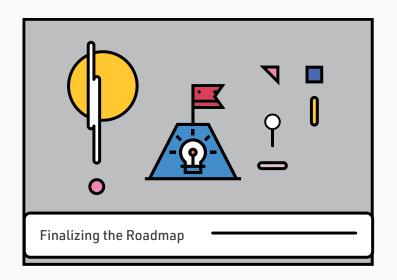
FIGURE 11

Sample Clustering of Opportunities (Indonesian Context) to Identify Enablers of Prioritized Recommendations

SUPPORTING ENABLERS ARE REQUIRED TO DRIVE

OPPORTUNITIES #1, #9, AND #3 FOR BALIKPAPAN

● Cluster for Recommendation 1

○ Cluster for Recommendation 2

● Cluster for Recommendation 3

Finalizing the Roadmap

3 STEP THREE:
FINALIZING THE ROADMAP

DEVELOPING A DETAILED ACTION PLAN FOR EACH RECOMMENDATION

Once the recommendations are finalized, a roadmap of the action plan can now be developed. The MSDI delivery team may wish to develop a preliminary version of this detailed action plan, before initiating a discussion on this with the city, in order to ensure more structured feedback is obtained from city counterparts. The MSDI delivery team may also decide to make informal phone calls to their counterparts, in case further inputs are needed in the preliminary action plan development.
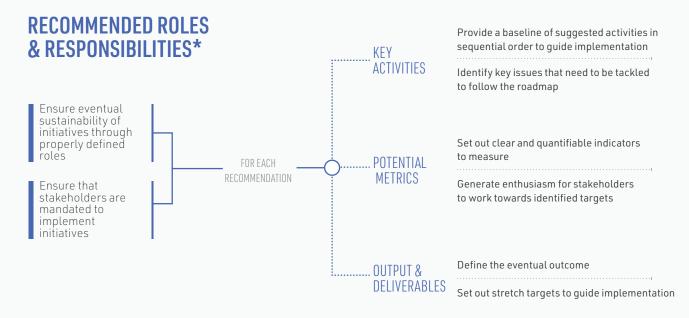
The methodology to create a detailed action plan itself is built based on the agreed recommendations from the previous step. An organizing frame (see Figures 12 and 13 for further context) is used to develop the recommendations into an MSDI roadmap. In order to kick-start the implementation of each recommendation, four key ingredients are required:

1. **Roles and responsibilities** for key stakeholders to define the scope of work as well as the mandate to initiate each recommendation. This facilitates clear roles and avoids potential duplication of work.

2. **Key actions** are important to provide a baseline of the suggested activities to be carried out. These actions are not prescriptive, but set out broad goals for implementation.

3. **Potential metrics** are defined to allow progress to be tracked. This is a key consideration to support monitoring and evaluation of the implementation of the roadmap.

4. **Output/deliverables** (baseline as well as stretch targets) that will allow key stakeholders to work towards common goals in order to implement each recommendation.

In addition, each roadmap needs to be phased across three time horizons (see Figure 14). This allows for work to be done incrementally while acknowledging the limitations on time and manpower resources required to fulfil key actions as defined. **The immediate strategic focus for cities in implementing MSDI should be on Horizon 1 (within 1-2 years), where proof-of-concepts are tested and 'quick-wins' are achieved in order to build momentum for furthering each recommendation.**
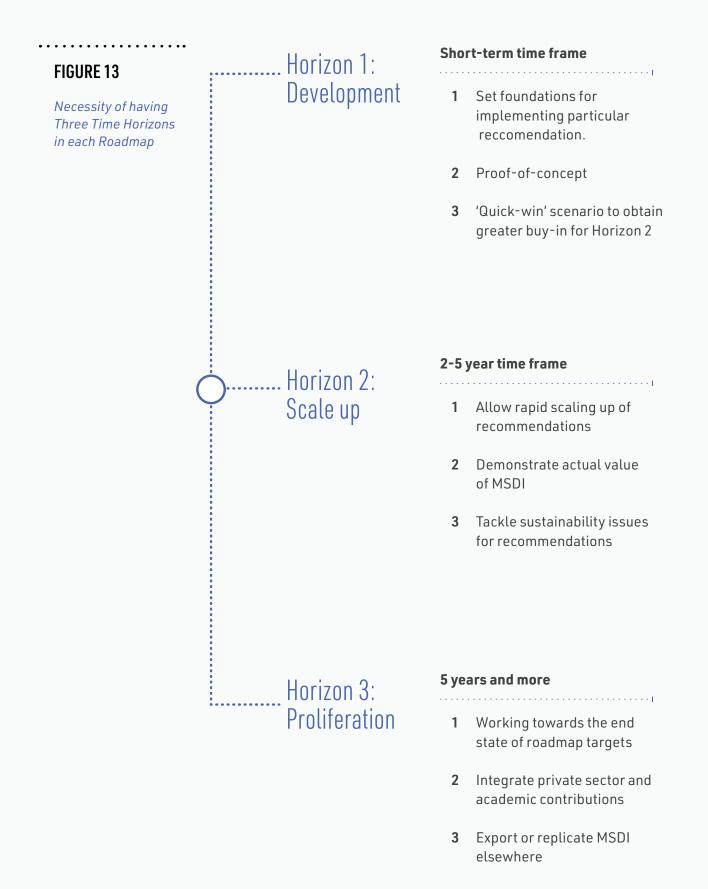
Once the detailed action plan is complete, a summary of actions across the three time horizons are developed for quick reference as shown in the diagram below.

RECOMMENDED ROLES & RESPONSIBILITIES*

Ensure eventual sustainability of initiatives through properly defined roles

Ensure that stakeholders are mandated to implement initiatives

FOR EACH RECOMMENDATION

KEY ACTIVITIES

Provide a baseline of suggested activities in sequential order to guide implementation

Identify key issues that need to be tackled to follow the roadmap

POTENTIAL METRICS

Set out clear and quantifiable indicators to measure

Generate enthusiasm for stakeholders to work towards identified targets

OUTPUT & DELIVERABLES

Define the eventual outcome

Set out stretch targets to guide implementation

FIGURE 12

Key Elements of an MSDI Roadmap and their Significance

FIGURE 13

Necessity of having Three Time Horizons in each Roadmap

Horizon 1: Development

Short-term time frame

1 Set foundations for implementing particular reccomendation.

2 Proof-of-concept

3 'Quick-win' scenario to obtain greater buy-in for Horizon 2

Horizon 2: Scale up

2–5 year time frame

1 Allow rapid scaling up of recommendations

2 Demonstrate actual value of MSDI

3 Tackle sustainability issues for recommendations

Horizon 3: Proliferation

5 years and more

1 Working towards the end state of roadmap targets

2 Integrate private sector and academic contributions

3 Export or replicate MSDI elsewhere

This completes the roadmap development process, with the MSDI roadmap being the key output. However, it is equally important to note the critical shift in thinking that it will engender in city agency representatives. For example, throughout the development of the roadmap, city agencies come together to discuss, debate and align on common relevant issues (e.g., priority sectors, required regulatory frameworks etc.) These discussions form the basis for a collaborative working model, which in the long-term ensures the sustainability of MSDI implementation. The process by which cities arrive at the roadmap is just as important as the roadmap itself and the MSDI delivery team must think of the roadmap development as a process-oriented approach, as much as the roadmap is a 'final product'.

FIGURE 14

Sample Summary of Next Steps (Indonesian Context) across the Three Recommendations and Three Time Horizons

	HORIZION 1 (1-2 YRS)	HORIZION 2 (WITHIN 5 YRS)	HORIZION 3 (5YRS ONWARDS)
Develop and institutionalize Balikpapan's MSDI	1. Develop Balikpapan's MSDI framework and implementation roadmap. 2. Establish a master list of Fundamental Datasets. 3. Initiate preliminary competency analysis	1. Establish a data collection and request methodology. 2. Further develop a competency framework of geospatial skills.	1. Establish a sustainable, full-fledged MSDI model with wider linkages to academia, industry and communities.
Develop BAPPEDA's geoportal as a clearing house for Balikpapan	Gather requirements and develop basic functionalities for Simtaru.	1. Develop public-facing services and share non-sensitive data. 2. Aggregate datasets from various data hubs / systems into Simtaru.	Develop existing geoportal geoportal into a full-fledged central geoportal with both internal and public-facing services.
Build strategic geo-spatial capabilities with a focus on inter-agency collaboration and targeted training	Establish Geocommunities to tackle first-priority urban issues, and develop outcome indicators.	1. Operationalize Geocommunities and scale upto include those for lower-priority issues. 2. Conduct targeted geospatial courses.	1. Expand Geocommunities into a network across city sectors. 2. Implement longer-term capacity building courses.

DEVELOPING A MONITORING AND EVALUATION (M&E) FRAMEWORK

OVERVIEW

Before executing the various activities, it is important to develop a robust Monitoring and Evaluation (M&E) Framework as it will provide the city with a clear set of metrics to track MSDI implementation and progress on expected outcomes. Cities may already have existing indicators for their programs, along with an evaluation framework. An MSDI delivery team is advised to research these indicators and framework beforehand and propose an M&E framework that aligns with these existing processes, to ensure that MSDI activities are mainstreamed into existing city processes[10].

....

10   *For example, in the Indonesian context, municipalities tend to already have their broad lists of programs organized in an RPJMD (Mid-term Municipal Development Plan), along with their associated KPIs. An MSDI delivery team should acquaint themselves with these documents, to ensure that the proposed activities can also be evaluated using the existing, legally-accepted evaluation framework, where ever possible. However, given the often compliance-driven format of existing evaluation framework (rather than a results, or process-driven evaluation), teams are advised to expand the evaluation framework using the approach suggested in this chapter.*

MSDI Roadmap development is a highly interactive and collaborative process and sets the common ground for all agencies to work together towards the goal of data-driven planning. The M&E framework serves as a simple means to track and sustain this multi-year complex endeavor and help inform the way forward, especially with respect to areas that require further strengthening during implementation. The M&E framework does this by providing a set of input and output indicators associated with each key and sub activity, to be tracked at regular intervals to evaluate progress towards the desired outcome.

Thus, the purposes of developing an M&E Framework for MSDI implementation are:

- **Understand the context** – indicators such as number of geospatially trained staff can serve as basic information to evaluate levels of geospatial capacity.

- **Readjust strategies** – a performance assessment of a program can be leveraged to inform cities as to whether the existing implementation strategy is performing well, or if refinements are needed.

- **Improve Processes and Operations** – by enabling teams and officials to readjust their MSDI strategies, the implementation of an M&E framework will also contribute to the improvement of existing MSDI processes and operations.

- **Establish Accountability** – In the context of an MSDI, city governments may be asked to report the progress of an activity to their supervisors, or their local legislative bodies. Objective progress tracking through the M&E Framework ensures accountability of activities associated with MSDI (e.g. the Lead Agency or the MSDI delivery team).

- **Provide Evidence for Funding Needs**- tracking MSDI progress through M&E can serve as the basis for demonstrating the need for financial support across IPDS framework pillars to donors and the national government.

Finally, the M&E framework can also serve as a basis for developing a Geospatial Masterplan that brings together government agencies, businesses, academia and citizens to enhance decision-making and improve the quality of life in cities.

KEY AREAS FOR MONITORING MSDI AND EVALUATING ITS OUTCOMES

Throughout the design of activities and their corresponding indicators, MSDI delivery teams and their city stakeholders should still organize their recommendations of programs and indicators according to the IPDS framework. This is because the interconnected nature of indicators within the individual pillars means that the indicators associated with one particular activity can contribute to the initiation of activities under the other pillars (e.g., number of geospatial staff trained in GIS can serve as a basis for the initiation of a Competency Framework exercise). In total, there are **five key areas** (building on the IPDS framework) with corresponding indicators for monitoring MSDI implementation and evaluating its outcomes. They include:

STRATEGY AND DIRECTION:

Indicators developed by the city government should address macro questions such as, 'Are we doing the right thing to achieve our goals? Are we implementing the MSDI Roadmap as effectively as possible? Do we need to shift our course of action?'

GOVERNANCE AND OPERATIONS:

The **Institutional Arrangements** pillar of IPDS lays out regulations and communication protocols for enabling smooth workflow between departments and facilitates ease of data sharing. Measurable indicators will help gauge whether or not the city government is administering these well. Indicators such as datasets shared between specific departments for informing urban planning would help the city government ask questions such as: 'Are we interpreting and implementing the regulations and protocols effectively?'

HUMAN RESOURCE CAPACITY:

One of the key indicators to measure a city's geospatial readiness is capacity development achieved through awareness building and training programs. Indicators developed to assess **People** skills should be founded on questions such as, 'Are staff improving their capabilities and skills to address city planning issues using geospatial approaches?'

DATA:

Adoption of **data** and metadata standards, as well as the number of FDS collected by cities are some examples of concrete outputs that can be measured under this aspect. Corresponding questions may be, 'Are outputs appropriate to the city's urban planning and performance goals and do they meet the required standards?'.

SYSTEMS/ ACCESS:

The **Systems** component caters to enabling equitable access to data and products developed within MSDI. One potential relevant question to assess this may include: 'Are people able to access and share data from the various agencies?', which can be measured by indicators such as number of times data has been downloaded, or number of times a portal has been visited.'

To maintain its relevance to the context in which an MSDI is being implemented, **the M&E framework should be designed with the flexibility to allow city governments to develop indicators by learning from their own experience, improving planning and allocating resources for effective urban data governance and management**. The process of evolving these indicators may be done via a collaborative approach between agencies in order to instill ownership of the process within city agencies. The indicators developed can then be used as KPIs for city agencies, officials and staff, depending on the scale at which they are applicable.

CHAPTER 4:
COMPONENTS OF MUNICIPAL SPATIAL DATA INFRASTRUCTURE (MSDI) OPERATIONALIZATION

CHAPTER 4:
COMPONENTS OF MUNICIPAL SPATIAL DATA INFRASTRUCTURE (MSDI) OPERATIONALIZATION

The development of the MSDI Roadmap in Chapter 3 elaborated interventions across the four Institutional Arrangements, People, Data, Systems (IPDS) building blocks and offered a blueprint for the implementation that has to be operationalized in relation to the needs of a specific city. While the IPDS pillars are universal to all cities wishing to apply MSDI and CPL's products for each of the pillars can be utilized to move the engagement forward, the specifics or the pathway to operationalization is likely to vary across city contexts. The operationalization of the IPDS framework is flexible and allows for multiple entry points to MSDI development, that is, the city can initiate activities under any of the pillars where an ongoing initiative or strong interest from the stakeholders exists. Unlike a civil works project, there is no readily-available standard construction code for MSDI implementation. As such, it is very important to invest time and resources to flesh out this "blueprint" (Chapter 3) to define a meaningful and practical implementation process for each city (Chapter 4).

Despite the flexibility of the IPDS Framework, the CPL experience has shown that it is critical to encourage the city to initiate interventions related to the Institutional Arrangements pillar in parallel. **Initiation and eventual establishment of the two prongs of the Institutional Pillar, namely MSDI Regulations and Organizational Structure, significantly enhances the effective operationalization of other pillars. In this sense, the "I" pillar sets the foundation for the entire MSDI by providing the institutional structure and legal basis for all future implementation activities**. For example, efforts to standardize geospatial data will not be sustainable unless they are accompanied by a regulation that legitimizes the enforcement of such standards. Similarly, despite the establishment of a state-of-the-art geoportal, data sharing will not be sustainable unless the process is mainstreamed to day-to-day city operations through an official mandate by city's decision makers.

This chapter and its associated Annex 2 focuses on operationalization under the Institutions pillar and briefly outlines some of the other aspects such as financial planning and partnerships needed for full implementation of the MSDI. 'How to' guides for interventions under the remaining pillars (People, Data, Systems) are forthcoming as follows:

People pillar – City MSDI Competencies, Capacity Building and related diagnostics

Data pillar – Fundamental Data Sets and related diagnostics

Systems pillar –City Level geoportals and associated technical materials

OPERATIONALIZING THE MSDI INSTITUTIONAL ARRANGEMENTS PILLAR

This comprises four main aspects:

1. Creating a legal basis to enforce MSDI implementation

2. Institutionalizing an organizational structure that advances the various MSDI activities

3. Upon reaching a steady state, expanding the reach of MSDI by partnering with relevant local actors

4. Financial planning

FORMULATING AND ENACTING MSDI REGULATIONS

One aspect which is fundamental to effectively operationalize the components of an MSDI from an Institutional Arrangement perspective is regulations. A system of robust MSDI regulations can legitimize city officials' efforts to engage in activities that pertain to improving the MSDI, or to address the challenges that are preventing its smooth implementation. Note that while an MSDI regulation is capable of addressing some of the challenges that may hinder MSDI implementations, the form of the regulation itself may vary, depending on context in which an MSDI is being implemented, namely its existing regulatory environment, as well as its corresponding governmental structure. This implies that there needs to be alignment between policies for data governance and management at all levels of the government – national, provincial and city, as the context may require. In principle however, an MSDI regulation can be thought of to be typically comprised of

an **MSDI Overall/ Umbrella Regulation** (For example, See Annex 2 on MSDI Overall Regulation), and its **supporting technical guidelines derived from the regulations** (For example, see Annex 2 on Data Standards and Protocols)

As its name suggests, an **MSDI Overall/ Umbrella Regulation** enforces core provisions that enable city governments to implement an MSDI. An overview of the key elements of the regulations is below (See full regulation outline as presented in Annex 2):

- Definition of the **objectives of the regulations**, emphasizing the establishment of MSDI as a key prerequisite for cities to utilize geospatial data in a sustainable manner to meet city goals.

- **General conditions of the regulation** include the jurisdiction that the regulation applies to, clear responsibilities for enactment of the regulation and definitions of terminology.

- **Identifying key stakeholders of MSDI, along with their roles and responsibilities**. The city planning agency typically assumes the role of an MSDI coordinator, accompanied by the technical lead and representatives from all other agencies. This ensures that their functions can be executed seamlessly. For example, the MSDI Regulation delineates clear roles for technical leads, as well as data producers, users and processors. It is important to explain these concepts clearly to the city agencies through a range of workshops and meetings.

- Creating agile **Working Groups** comprising of priority departments relevant to addressing core challenges faced by the city (such as frequent flooding, health care etc.). The regulations will provide mandates that allow the MSDI Coordinator to create these groups (See also description of Organizational Structure below).

- **Establishing Geospatial Data Standards** across key domains to support data inter-operability, and geospatial data usage. The regulations

make provisions to allow the MSDI Coordinator to oversee the process through which each agency collects, processes and disseminates data.

- The regulations may optionally provide incentives to encourage stakeholders to use geospatial data on a day-to-day basis to devise city solutions. Disincentives may include departmental sanctions.

- Provisions for **conflict resolution** need to follow common practice in the local context (See Annex 2).

MSDI SUPPORTING REGULATIONS AND TECHNICAL GUIDELINES

These critical components of the MSDI Regulations are complemented by other forms of regulatory provisions, such as government orders, annexes to the main MSDI Regulation, or technical guide document, which can serve as enablers for the city government to implement the MSDI Roadmap.

To enable the proposed MSDI organizational structure, city governments need supporting documents to delineate detailed **protocols for communication** between stakeholders, for day to day workflow. These need to be developed and ratified in consensus with key stakeholders and representatives of the line departments. A high-level template developed for the Indonesian City of Semarang (a medium-capacity city), illustrates the workflow between different members of the MSDI organogram, as below:
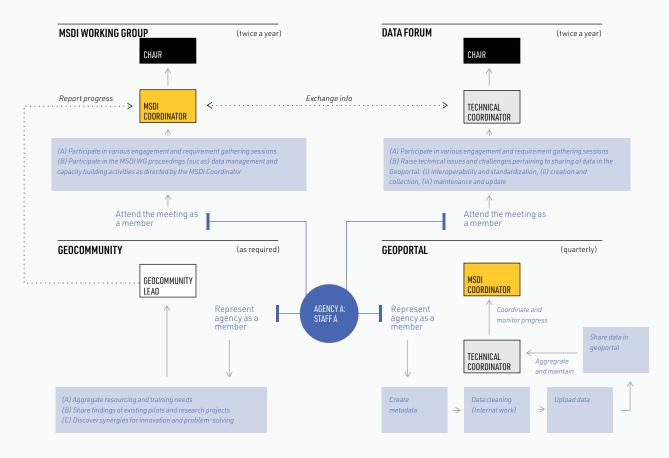
Protocols for data sharing should all be clearly defined in the regulation, to incentivize the creation of a culture of data sharing in the city government. Together, this provides a well institutionalized structure for inter-agency coordination for data sharing.

Developing **geospatial capacities** across all departments through conducting a **competency analysis**. If the framework is provided at the national level, city governments would need assistance to interpret this in ways that are suited to local levels.

FIGURE 15

Sample of MSDI communication protocols (see details on organizational structure below)

ROLE A: STAFF FROM STAKEHOLDER AGENCY WHO HAS DATA TO SHARE IN GEOPORTAL AND TAKE PART IN A GEOCOMMUNITY

Storing and maintaining data on a centralized public facing geoportal forms a key function of realizing the objectives of the MSDI. MSDI Regulations should therefore enable the implementation of a clearing house or a geoportal. It must provide possibilities for the city government to explore different types of hosting environments for data, such as cloud-based server or a database server, and other suitable technological innovations.

ORGANIZATIONAL STRUCTURE

Institutionalizing a formal organizational structure i.e., MSDI Working Group is highly recommended for seamless implementation of MSDI activities as it can help serve as the main focal point for all MSDI-related initiatives, be it policies, standards, activities, or the development of new systems. Globally, there are two recognized models for this, namely the voluntary[11] model and mandatory[12] model. The mechanism used depends upon the working environment of the city as well as its specific needs. Based on the MSDI delivery team's engagement with the city, a team can recommend actions in either of the two directions. In cities where a voluntary model is in place, protocols merely aim to guide the implementation of the MSDI working group. In cases where there is a requirement for a mandatory model, the MSDI working group is legalized through a regulation/decree. Consequently, corresponding protocols provide key elements to be stated in the regulation/decree.

This manual demonstrates one of the models as a representative example. The ideal organizational structure to be implemented will need to be discussed in collaboration with the city stakeholders on a case-by-case basis.

MSDI WORKING GROUP

At its core, the MSDI Working Group is a larger taskforce, comprised of representatives from key stakeholder agencies, that serves as the city's think tank for various activities pertaining to MSDI implementation. The formal structure and form of this working group may differ, depending on the format that is allowed by prevailing local regulations. It is important to have a clear definition of the MSDI Working Group and situate it in the universe of the city's institutional arrangements. Roles and responsibilities are assigned to members of this group, to execute tasks that pertain to resolving sector-specific issues, using geospatial approaches, in alignment with the MSDI vision and roadmap. The High-Level Forum on Global Geospatial Management Information, 2011 outlines the following functions for the working group:

....

11 An example of a country that uses the voluntary model is Canada. In Canada's case, formal partnership arrangements were put in place to facilitate CGDI development. Source: Canadian Geomatics Accord, 2007-2013

12   The mandatory model exists in the European Union and America. In America, different enforcement mechanisms are used, e.g. Brazil uses a Presidential Decree, Chile uses a Supreme Decree, while Mexico elaborates it in the National Law of Statistical and Geographical Information. Source: Spatial Data Infrastructure Manual for the Americas, 2013

- Coordinate the acquisition and production of geospatial data and information, according to priorities policies and programs.

- Coordinate the establishment of the MSDI plan.

- Coordinate the establishment of standards and specifications to support the production, dissemination, sharing and access to geospatial data and information.

- Propose mechanisms for certifying geospatial information made available to the public as official, authoritative data.

- Propose corrective measures for the handling of information which does not adhere to the adopted standards and specifications.

- Report directly on the progress of MSDI initiatives to the higher levels of government.

- Manage budgetary resources to implement MSDI.

- Promote the necessary capacity building and training for potential users of geospatial information.

Further, it is important to establish clear roles and responsibilities for members within the working group at the outset, as this clarifies job description and coordination protocols. Spelling this out also avoids mismanagement and redundancy of work. These definitions can be presented with an organogram, as it will provide useful context on the position and reporting structure of roles in relation to one another.

A typical organizational structure and the corresponding roles and responsibilities for an MSDI Working Group will comprise:

STEERING COMMITTEE:

This will consist of senior members of the city government who steer the MSDI working group in order to achieve the objectives of the roadmap. They are responsible for direction setting, reviewing progress at key milestones and making recommendations to enable effective implementation of MSDI.

LEAD AGENCY/MSDI COORDINATOR:

Operationalizing MSDI requires a key stakeholder in charge of coordinating the MSDI activities stated in the roadmap. The coordinator will usually be an agency with a mandate related to geospatial data management, and/or an agency with an existing role of coordinating various functions of the city and therefore able to encourage collaboration among agencies. The coordinator will play the role of a Secretariat, facilitating the functioning of MSDI, managing its resources and linking it to city priority initiatives.

TECHNICAL COORDINATOR:

This role is in charge of system architecture, data and the geoportal. In addition, the Technical Coordinator will be in charge of setting the standards for datasets and ensure that the different agencies follow agreed standards and protocols to improve data interoperability, creation of new geospatial datasets as well as maintenance and updating of existing geospatial datasets.

DATA CHAMPIONS:

These champions are representatives from every agency in the city and are responsible for the execution of various MSDI activities, linked to their Key Performance Indicators.

FIGURE 16

Sample of MSDI Working Group Structure

CITY MAYOR

STEERING COMMITTEE

MSDI COORDINATOR — Responsible for leading all MSDI activities and initiatives. Ideally an agency whose mandate is related to geospatial data management, and/or an agency whose existing role coordinates various functions of the city and is therefore is able to encourage collaboration among agencies.

MEMBER / DATA CHAMPIONS — Responsible for implementing MSDI activities. Ideally data champions from all agencies

Responsible for leading the technical aspects of MSDI, particularly data and system components, while also providing technical assistance to agencies — TECHNICAL COORDINATOR

TASKFORCE FOR CITY ISSUE #1
Led by respective agencies with members from relevant agencies

TASKFORCE FOR CITY ISSUE #2
Led by respective agencies with members from relevant agencies

GEOPORTAL ADMINISTRATION TASKFORCE
Led by the agency with technical capacity in IT infrastructure (i.e. the Technical Coordinator)

TASKFORCES:

These are usually formed to focus on specific areas of MSDI development and operation. They help identify data needs, methods to obtain data, possible partnerships for data acquisition and analysis as needed. These taskforces also identify capacity building needs.

Minimally, the above roles must be included in the MSDI working group structure. Taskforces may be established based on requirements and may also take the form of Geocommunities as needed (See the following section for a description of Geocommunities).

Selecting members for these various positions is also critical and the manner of doing it depends upon the city context. Ideally, it would be beneficial to list assigned representatives from every agency that will be involved in the working group, his/her current position in the city's overall institutional arrangement and the designated position in the MSDI working group. Then, the designation by position (instead of name) can be listed in the organogram. **Stating the position instead of a name will ensure sustainability of the working group in the long run, especially because staff rotation is a common exercise in many city contexts.**
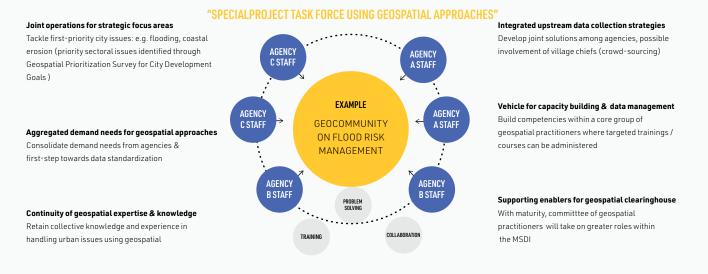
In terms of the steering committee, members will initially be selected from city agencies closely related to MSDI activities. In subsequent phases, this steering committee must expand to include new members from other agencies as well.

FIGURE 17

Sample of a Geocommunity structure

"SPECIALPROJECT TASK FORCE USING GEOSPATIAL APPROACHES"

Joint operations for strategic focus areas
Tackle first-priority city issues: e.g. flooding, coastal erosion (priority sectoral issues identified through Geospatial Prioritization Survey for City Development Goals)

Aggregated demand needs for geospatial approaches
Consolidate demand needs from agencies & first-step towards data standardization

Continuity of geospatial expertise & knowledge
Retain collective knowledge and experience in handling urban issues using geospatial

Integrated upstream data collection strategies
Develop joint solutions among agencies, possible involvement of village chiefs (crowd-sourcing)

Vehicle for capacity building & data management
Build competencies within a core group of geospatial practitioners where targeted trainings / courses can be administered

Supporting enablers for geospatial clearinghouse
With maturity, committtee of geospatial practitioners will take on greater roles within the MSDI

AGENCY C STAFF · AGENCY A STAFF · AGENCY C STAFF · AGENCY A STAFF · AGENCY B STAFF · AGENCY B STAFF

EXAMPLE
GEOCOMMUNITY ON FLOOD RISK MANAGEMENT

PROBLEM SOLVING · TRAINING · COLLABORATION

GEOCOMMUNITY – AN ISSUE-BASED GEOSPATIAL TASKFORCE

One less formal way to introduce geospatial approaches into a city's organizational framework is through the creation of a geospatial taskforce, geared towards addressing a particular issue using geospatial approaches. Most governments allow the creation of an ad-hoc group to address specific, or non-repeating issues. In the initial phase of MSDI implementation, a group such as the Geocommunity can meet regularly to discuss matters pertaining to the issue at hand (development of affordable housing complex, flood mitigation, construction of a new bridge, etc.)

The Geocommunity's primary mandate would be to discuss the activities, data and expertise needed to address these issues, and communicate them to the MSDI coordinator, and other city stakeholders, as relevant. In this manner, a Geocommunity can play a significant role in advancing the implementation of MSDI in a city.

In the longer term, Geocommunities can become focal points for developing geospatial capacity and expertize around strategic problems in priority sectors. They act as forums for experts and stakeholders to discuss and aggregate data needs for solving the problems, such as data collection methods and data standards, and developing practical strategies for meeting these needs. In this manner, Geocommunities offer a base for scaling up capacity building activities, such as through the development of a wider competency framework and Strategic Workforce Plan encompassing various strategic problems and institutionalizing geospatial awareness and competencies in the MSDI.

BOX 6: LEVERAGING EXISTING ACTIVITIES AND OPEN SOURCE PRODUCTS FOR MSDI

It may not always be possible to immediately initiate an MSDI, especially if the timing for the completion of the MSDI roadmap does not align with the city's municipal budgeting process. Missing the budgeting schedule can sometimes mean not having a budget allocated for an MSDI for an entire year, which could potentially diminish the momentum that MSDI implementation needs.

In such cases, teams and cities may need to think creatively to circumvent the constraint imposed by a municipal budgeting process. Two approaches that may be considered are:

- **Leverage existing programs to further the MSDI implementation** For example, some cities may already have a budgetary allocation to conduct training for staff. In this situation, it may be possible to redirect this budget to conduct geospatial training, therefore furthering efforts to build geospatial capacity, while still operating within the city's existing budget.

- **Open source data and applications** The cost of procuring satellite imagery, conducting surveys and purchasing software licenses can sometimes be expensive, to the point that it may not be possible for cities to procure them without a budget allocation. Teams may then opt to introduce open-source data (the USGS Earth Explorer website provides satellite imagery data of most of the Earth's surface for free). Open Street Map (OSM) may also be a good source, or open-source applications such as QGIS.

These low-cost solutions represent ways in which teams and cities can still move forward, even in the absence of immediate funding. The important thing to be achieved here is to preserve the momentum of the MSDI implementation effort.

FINANCIAL PLANNING

Multiple agencies of the city government generate and use data (e.g., road, water and sanitation etc.). Thus, to make geospatial data available in the form of information will require allocation of finances across relevant departments for data collection, data maintenance (in an accurate and standardized form), processing it through a centralized geoportal to support dissemination, procurement of services and developing tools, as well as training and capacity building. However, upon developing the roadmap and prioritizing activities, it may become apparent that the resources available are insufficient to undertake the activities. **Thus, it is important for the city to consider budget allocation upfront in the budget planning cycle, both on a year-to-year as well as long-term basis.**

Financial planning thus includes short-term planning for budgetary allocations on an annual basis and the long-term financial strategy.

In the short term, the following actions are essential for the city government to undertake:

- Developing a phased implementation plan for key activities agreed upon in the MSDI Roadmap and estimate manpower, equipment and financial resources needed.

- Identifying funding sources,i.e. either through the city's annual and mid-term budgets or through alternative sources of funding.

- Determining source of funding that is 'fit for purpose', i.e. funding through international cooperation, central government funding, sharing of costs at the city-level through agreements across agencies, and public-private partnerships. To further determine the viability for the use of funding, agencies should discuss the rationale for utilizing a particular funding

stream and which Key Performance Indicators (KPIs) or outcomes are to be met.

• Tracking expenditure, progress and outcomes through the M&E framework.

In the long term, city government agencies should collectively define the resources and policies needed to improve the use of geospatial data in supporting the development of the sectors. Depending on their capacity, city governments may conduct a cost-benefit analysis for MSDI activities and a demonstration of clear use cases that show value from collecting and visualizing geospatial information. They should also collectively devise geospatial data processes to maximize cost savings for the local government.

PARTNERSHIPS AND COOPERATION

Partnerships and cooperation are critical for the long-term sustainability of MSDI. A wide range of resources are required to address the needs of entire data lifecycle in cities. **Partnership arrangements have the potential to expand the city's pool of resources to perform the tasks associated with managing data throughout its lifecycle.**

For example, city government partnerships with national or provincial governments and/ or international lending agencies may provide financial support for implementing key activities of the MSDI. Partnerships with research institutions and academia can help implement and deepen geospatial skills through capacity building and training. In addition, given the technical nature of standards, city governments may also seek their assistance to synthesize and refine regulations. Further, private sector collaboration will allow outsourcing of some aspects of data-driven planning to qualified external firms and consultants (e.g. data collection, design, development and maintenance of the geoportal etc.).

BOX 7: THE ROLE OF FACILITATION IN ENSURING EFFECTIVE IMPLEMENTATION

Throughout the roadmap development and implementation, it is essential to keep relevant stakeholders involved in the process to ensure successful absorption and mainstreaming of MSDI concepts and approaches. Thus, the MSDI delivery team should involve relevant stakeholders at every stage in the project. In the short term, aligning relevant stakeholders early on in the project can ensure the immediate applicability of recommended activities to cities. As for the medium to longer-term, early inclusion of stakeholders in the project can yield better buy-in, in the form of local legitimacy from the counterparts, which can subsequently contribute to ensuring the sustainability of MSDI.

Facilitation could be done through a series of workshops, simulated exercises and discussions that demonstrate concepts and workflow scenarios. Further, responses from city agencies on the whole process of developing an MSDI roadmap can be elicited through these activities. The inputs gathered from these workshops and discussions with city agencies can then be integrated into the roadmap, in order to motivate them to initiate, internalize and own the entire process. Given the importance of facilitating these discussions and communicating the entire process to MSDI stakeholders to get their buy-in, clear and effective communication becomes a cornerstone for successfully implementing MSDI. Please refer to Annex 1 for further details on facilitation modalities.

CITY STORIES-
EXPERIENCES FROM CITY PLANNING LABS (CPL) CITIES

CPL's partner cities (Semarang, Denpasar and Balikpapan) have demonstrated strong commitment and capacity to develop and implement the Municipal Spatial Data Infrastructure (MSDI) roadmap towards enabling data-driven urban planning and service delivery. Each of these cities have embarked on distinct trajectories to implement the Institutional Arrangements, People, Data, Systems (IPDS) framework, and the following section chronicles key highlights in their journey.

SEMARANG

Semarang was the first among CPL partner cities to establish data governance to coordinate regulatory and technical geospatial initiatives and solutions. However, this was not the starting point. The city started with data analytics and innovations in data generation, including leveraging remote sensing data for its spatial plan development. In parallel, the Mayor launched the Smart Cities Initiative that intensified the need for inter-departmental coordination. Jointly, the need for quality data for the spatial plan development and the Smart City initiative highlighted the need to establish seamless and sustainable data sharing mechanisms.

Consequently, an MSDI policy framework was established through the efforts of the key city agencies, especially BAPPEDA (City Planning Agency), DISKOMINFO (ICT Agency) and DISTARU (Spatial Planning Agency). Semarang has rolled out several strategic initiatives to create the right policies, frameworks, and organizational structures across all line departments. **The Mayoral Regulation on the Integrated Data Management System clearly articulates the MSDI coordination structures required to support Semarang's MSDI development. This regulatory intervention has been foundational for Semarang's Smart City**

Initiative. The city is now tracking progress on the four IPDS pillars using the MSDI Roadmap.

The existing regulation is being developed further to include regulatory data standards that combine both statistical and geospatial domains to produce high-quality, integrated data. In parallel, the city has prioritized the development and linkage of a centralized geoportal in DISTARU to other agencies' portals, and initiated capacity building activities for all key line departments to utilize Urban Planning Tools for infrastructure land suitability identification and better service delivery.

For example, the Health Department and BAPPEDA recently used the Land Suitability Tool developed by CPL to identify the optimal location for a new hospital.

The city has initiated the setting up of MSDI committees and working groups to leverage geospatial information for decision making and enhance productivity by collaborating across sectors and local government hierarchies.

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DENPASAR

Denpasar demonstrates a strong institutional and organizational commitment to overcoming coordination challenges in geospatial data sharing. **Early in its partnership with CPL, Denpasar launched its geoportal in February 2017 to facilitate shared and efficient use of inter-sectoral data as a building block for e-governance and Smart Cities.**

A year later, a fully functional geoportal is encouraging data sharing and inter-departmental coordination for evidence-led planning. It is also playing a role in expediting the city's digital transformation by supporting integration of the city's geospatial data and web services into broader e-governance strategies.

However, this journey was not straightforward. With the geoportal launch, the city essentially chose the Systems pillar as the starting point for its MSDI. However, city stakeholders soon realized that the geoportal's functionality was dependent on a culture of inter-agency data sharing as well as the capacity of line agencies to analyze the data and draw insights from it.

At the time, without an MSDI Roadmap, the priority tasks were not yet established to ensure that the geoportal was embedded in a set of enabling and supportive actions.

By 2018, the city had commenced MSDI Roadmap development, and identified capacity building as a priority for utilization of geospatial information by all agencies. On the Mayor's request, CPL has developed a Capacity Building Program based on a competency assessment, involving strategic and hands-on sessions that build up departmental competencies. The training modules range from the most general geospatial competencies to sector specific skillsets and analytical abilities. The city staff have exhibited high levels of motivation to augment their core abilities and work functions.

Bolstered by their accomplishments, Denpasar is currently developing a holistic data governance regulation in the form of an MSDI Mayoral Decree, which will encompass communication protocols for data access, sharing and policies and regulations for data standards, along with MSDI coordination organization structures.

BALIKPAPAN

The city government has played a major role in fostering the growth of the broader geospatial ecosystem in Balikpapan and has selected multiple entry points to the process of institutionalizing MSDI from the outset. Balikpapan exhibits a very high level of motivation and collaborative work ethic to drive the process of realizing the MSDI and has embraced the lessons learned from prior CPL engagements in Semarang and Denpasar.

Balikpapan has initiated the recommended Institutional Arrangements to support the development of MSDI. Strong existing collaboration across the agencies has allowed the city to expedite the drafting of a local government decree for MSDI, which includes the city's commitment to setting up an MSDI Working Group. Balikpapan is the first city to have initiated partnership with the National Geospatial Agency in Indonesia (BIG) to align its local initiatives for setting up MSDI with recommended national-level policies such as the One Map policy.

In balancing competing demands for limited resources, the city prioritized the development of the MSDI Roadmap with phased initiatives over a period of five years. The city identified key problems to address by mobilizing geospatial data and assigned priority departments to participate in the city's first Geocommunity. This agile working group is responsible for production, maintenance, and sharing of data. In one example, to address seasonal flooding affecting a socially vulnerable population, the city is using the Geocommunity on Flooding as a means to document disaggregated demographic data (age, gender, and education) on affected families, and has started the task of creating its Fundamental Data Set to support the initiative.

As a significant expression of political backing, the Mayor of Balikpapan has issued directives to BAPPEDA (city planning agency) to integrate priority activities from the MSDI Roadmap as Key Performance Indicators for all departmental Data Champions in the city's Mid-Term Development Plan (RPJMD) and Strategic Plan (RENSTRA).

This incorporation of the roadmap into the city's existing planning cycle will enable the development of a M&E system to measure the implementation of the MSDI and its intended and unintended outcomes.

ANNEX 1
FACILITATION FORMATS

FACILITATION FORMATS

Operationalizing Municipal Spatial Data Infrastructure (MSDI) in a sustainable manner is complex and largely depends upon stakeholder buy-in. Consequently, **consensus building is a critical component** of this journey. Further, since MSDI is equally a process as it is a product, it is essential to involve relevant stakeholders at every stage of the MSDI roadmap development and implementation process.

Thus, to elicit responses effectively, the MSDI delivery team should consider appropriate facilitation formats and pay particular attention to these three aspects:

Communication: inform participants about the project, its approach, and opportunities to participate in public engagement activities.

Collaboration: create opportunities to collaboratively discuss and evaluate discussion outcomes.

Community and stakeholder relations: build trust and credibility during the facilitation process.

This section describes planning considerations and effective techniques for successful stakeholder engagement, followed by engagement types and formats that can be used during the process of the MSDI roadmap development and implementation.

PLANNING CONSIDERATIONS

PICKING A VENUE

While it may appear simple, picking the right venue can go a long way in ensuring the success of workshops and meetings. For instance, travel time needs to be considered to ensure maximum participation. In some specific cases, it may be effective to conduct meetings at the office of senior officials such as the Office of the City Mayor or City Secretary. Otherwise, neutral venues (such as hotels and cafes), where seating arrangements can be neutrally re-determined, may be appropriate as they help avoid any biases or power dynamics.

FINALIZING A TIME AND BUDGET

Being aware of the city's schedule and timelines is essential not only to better align the annual budgeting and workplan processes with the requirements and outputs of the MSDI roadmap development, but also to plan workshops at convenient times for the city. This will ensure full participation by agencies. It is also useful to be aware of local customs such as the hours of operation, holidays and prayer times since this impacts meeting scheduling and timelines.

Understanding the budgetary implications of embarking on the MSDI roadmap development process is important for cities to allocate adequate resources. For instance, the cost of conducting workshops, soliciting inputs and advancing the various outputs are to be factored into a budget to be earmarked for this purpose.

EFFECTIVE TECHNIQUES FOR SUCCESSFUL STAKEHOLDER ENGAGEMENT

- Ensure that key stakeholders have the necessary knowledge and communication skills to participate effectively in the engagement sessions.

- Share a personal introduction at the start of every discussion (minimally name and agency represented).

- Set clear rules to define the process, tools used and outcome desired.

- Remember to include ice breakers at key points to keep the audience engaged.

- Ensure a balanced opinion and avoid dominance or bias by individuals/ members of a particular group/agency; do not criticize any idea during the session. Every city and country has different challenges and cultures- sharing strong critiques may offend some people.

- Aim for inclusive and effective representation by establishing a mechanism to reach out to all relevant stakeholders.

- Record every idea clearly.

- Be attentive to your audience, and flexible with the engagement method; if the format you planned for is not successful in eliciting

necessary responses, be flexible and shift to other methods seamlessly.

- Use casestudies to help set the context for specific technical discussions and a combination of presentations and active discussions to increase the sense of ownership among participants.

- Never push someone to agree on something they are uncomfortable with. Give them time to think or explain the issues further. Plan to follow up with them later.

- Create effective and visual handouts/presentation material that makes it easy to absorb content.

- Remember to translate presentation and handout materials into the local language for them to be maximally effective.

- Engage an interpreter for non-English speaking groups to avoid miscommunication and to ensure that the messages are fully absorbed. Bringing on board interpreters who are familiar with technical terms related to MSDI would be advantageous.

Finally, patience is key. While it is common to suggest timelines during stakeholder engagements, lower capacity agencies are likely to require additional time to complete exercises and more follow-up explanations, clarifications and one-on-one engagement.

ENGAGEMENT TYPES

During the course of developing the MSDI roadmap, the MSDI delivery team will need to use one or more of the engagement types listed below. It is important to understand the benefits and drawbacks of each approach before proceeding.

SMALL AND CLOSED MEETING

This setting is useful to obtain buy-in from city leaders e.g., Mayor, Vice Mayor as well as strategic discussions with MSDI lead and co-lead agencies. It will also help to align key agencies and enable seamless collaboration between these agencies. A meeting of this format may also be considered when an MSDI delivery team intends to discuss and elicit feedback on potentially sensitive issues from key agencies and actors (e.g. sectors to be focused on during the MSDI implementation process, core structure of the MSDI organizational framework etc.)

INFORMAL MEETING

The importance of developing a rapport with city agencies and officials when conceiving and implementing MSDI cannot be overstated. Informal discussions are a great way to build relationships, share information and have candid conversations on opportunities and challenges. **While not tangibly linked to the decision-making process, these interactions are powerful tools to elicit ideas and opinions that may not be shared during structured meeting settings.**

TARGETED WORKSHOP

Stakeholders may sometimes raise the need for an immediate workshop on a specific topic, such as: metadata standards, Geographic Information Systems (GIS) etc. In such cases, **a targeted workshop format would be useful for teams to address a specific knowledge gap that may require a more structured learning environment.** Depending on the topic, this activity could take on the form of a technical deep-dive workshop (such as GIS training), or a collaborative workshop, where agencies discuss their opinions of a subject facilitated by the MSDI delivery team (such as determining protocols for data sharing). Being typically done at the request of the counterpart, this form of workshop can potentially be a way for the MSDI delivery team to build a strong rapport with key stakeholders.

FULL WORKSHOP

In the case of a large workshop, the discussion should be led by the MSDI lead and co-lead agencies. Facilitators should ideally approach other stakeholders for discussions once the MSDI lead and co-lead agencies have set the parameters for discussion. **Participants must comprise a mix of both senior and technical staff as they bring equally important perspectives that are critical to different aspects of the roadmap.** For instance, senior management is best positioned to discuss high-level issues covering policies and commitments required from the different agencies. On the other hand, technical staff maybe better positioned to understand the day-to-day tasks and implementation specifics.
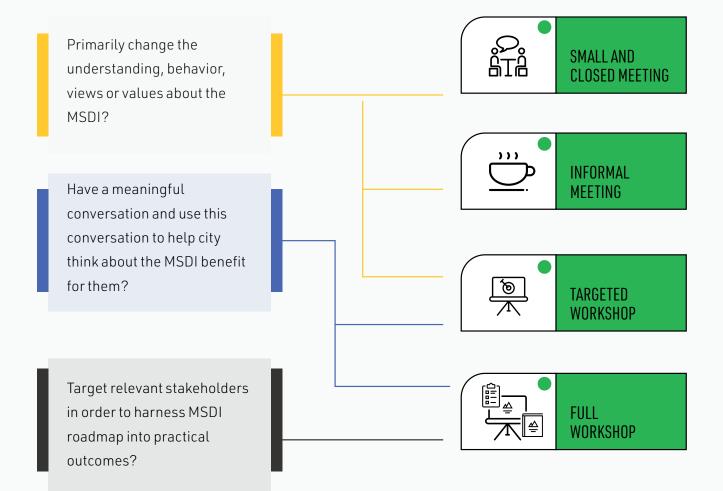
Figure 18 can serve as a useful guide to understand which modality will work for a particular purpose.

ARE YOU LOOKING TO...

FIGURE 18

Guide to Choosing a Meeting Modality

Primarily change the understanding, behavior, views or values about the MSDI?

Have a meaningful conversation and use this conversation to help city think about the MSDI benefit for them?

Target relevant stakeholders in order to harness MSDI roadmap into practical outcomes?

SMALL AND CLOSED MEETING

INFORMAL MEETING

TARGETED WORKSHOP

FULL WORKSHOP

ENGAGEMENT FORMATS

MSDI roadmap development exercises are typically intense and a vast amount of material would need to be digested by city stakeholders. Thus, it may be necessary to repeat presentations in various formats for better absorption. Reinforcing fundamental concepts during every engagement may also be required as new participants may attend the sessions. Once the city stakeholders fully understand all aspects of MSDI, it is expected that they will be able co-develop the MSDI roadmap.

Of the four engagement types described above, during the course of conducting targeted workshops or full workshops, several engagement formats may be explored for effective communication as described below:

SMALL GROUP DISCUSSION:

Large groups can sometimes become dominated by a few people which can hinder the creativity and contributions of others. In a small group, participants tend to speak more openly and get actively involved in discussions. Such a setting also provides an opportunity for everyone to speak. Given this, it may be useful to split a large group into several smaller groups, each with a facilitator.

TIME: 30-60 minutes

PARTICIPANTS: 4-10/group

PROCESS:

- Have a list of questions to keep the discussion focused. These questions can be written on the flipchart/board for visibility.

- Encourage people to speak and provide inputs.

- At the end of the discussion, nominate one member per group to summarize the discussion and share it with other groups

IDEAL FOR: detailed discussions such as for 'Consensus Building through a Diagnostic Review' (Step 1 of the MSDI roadmap development process), where various perspectives need to be registered in an exhaustive manner.

GO-ROUND

This method can be combined with the Small Group Discussion format. It involves going around the group and allowing every

participant to speak on the subject without interruption or comments from others. However, there should be a timekeeper to set the time limit as necessary.

META-PLANNING

This simple technique encourages individuals to express their thoughts during discussion. It helps incorporate everyone's ideas and contributions within a short amount of time. It also enables the group to arrive at some quick conclusions.

TIME: 30-60 minutes

PARTICIPANTS: 4-10/group

PROCESS:

- Ask participants to write one idea per post-it note and then place the notes onto a board, sheet of flipchart paper, wall space, or similar.

- When all the notes are on the board, the facilitator can then collate similar ideas together (since post-it notes can be moved around easily) and group them into sub-headings.

- Discuss the results and arrive at agreements.

IDEAL FOR: discussions to build awareness on the merits of the MSDI roadmap. For example, by simulating a case study during this exercise, participants can play the role of decision-makers; this enables them to learn by doing.

FLIPCHARTS

Using flipcharts can provide a creative yet structured format to discussions and help bring focus to the group.

TIME: 15-30 minutes

PARTICIPANTS: 3-20

PROCESS:

- Write headings on the flipchart and focus the group's attention on the issue or question at hand.

- Discuss the issue and draw/ write it directly on the flipchart. This can be a matrix, diagram, mind-map or any other form of representation.

- Use different colors and bullet points when writing on the flipchart.

IDEAL FOR: identifying the best institutional arrangement (working structure) for the city. In order to make it maximally effective, draw

the diagram during the workshop and raise points around ownership of the activities across the stakeholders present.

THREE-STAR RATING

Three-star rating is a visual group decision-making technique using colored stickers. It is similar to voting, except that it enables participants to choose more than one option.

TIME: 15-20 minutes

PARTICIPANTS: 3-30

PROCESS:

- Provide colored stickers to participants to rate their preferred options

- Once participants place the colored stickers across the various options, a visual record of the preferred option will be obtained

- This method should be combined with a discussion to confirm the results

IDEAL FOR: identifying Geospatial Prioritization for City Development goals

as part of 'Consensus Building through a Diagnostic Review' (Step 1 of the MSDI roadmap development process).

PARKING LOT

This method involves the use of a blank paper stuck on the wall for everyone to provide their inputs or feedback. The nature of points to be raised is not restricted to the topic in discussion (it could include aspects such as the flow of the discussion) and can be added to at any point during the workshop. While reassuring the participants that their points are heard, it allows the facilitator to address the comments at the end of the session, with minimal disruption to the flow.

ANNEX 2

GUIDING PRINCIPLES FOR FORMULATING MSDI REGULATIONS

GUIDING PRINCIPLES FOR FORMULATING MSDI REGULATIONS

The formulation of regulations forms a critical step for city governments to operationalize MSDI and its components. It defines organizational structures, roles and responsibilities and regulations and protocols within which city agencies should carry out their functions. The regulations must be clear, accurate, explain their purpose as well as expected outcomes. It must include obligatory and optional functions of the city government as well as roles and responsibilities to execute management of geospatial data.

This annex provides guidelines and general principles for city governments and their agencies to formulate a decree for data governance and management (applicable at the city government level).

PROVISIONS FOR THE OVERALL MSDI REGULATION:

MSDI Regulations should make provisions for the following aspects:

1 **MSDI REGULATIONS PROVIDE DIRECTIVES TO CITY GOVERNMENTS TO OPERATIONALIZE, GOVERN AND MANAGE GEOSPATIAL DATA INFRASTRUCTURE. THIS INCLUDES:**

- Guidelines on the rules and procedures that apply to the use and management of geospatial data in the city.

- Mandates to city government for setting up organizational structures needed for effective geospatial data governance and management.

- Directives for stipulating roles and responsibilities for stakeholders to manage, use, and share data, covering all aspects of the lifecycle of data management.

- Guiding principles on communication protocols for effective coordination in operationalizing MSDI.

- Definitions of components that qualify geospatial data.

- Principles to guide city governments to augment geospatial capacities across all departments.

- Information to all city agencies on modes of accessing spatial information in the city, as relevant to the city.

- Mandates for financial planning.

2 SETTING LEGAL FOUNDATIONS FOR MSDI FOR CITY GOVERNMENTS: POLICIES, PRINCIPLES, GUIDELINES, REGULATIONS AND PROTOCOLS

Alignment of city government regulations for MSDI, with national and/or provincial level policies and laws (depending on the context), is critical to support decision making at multiple levels of government. It also enables peer-to-peer coordination and learning between city governments.

Hence, MSDI regulations should emphasize the importance of assessing applicable policies, regulations, guidelines at national or provincial levels as references to develop regulations at the city government level. For example, some countries have established NSDI encompassing policies at the national level, to be referred to by the city government to implement MSDI.

Given this, city government regulations should include principles for data governance and management, standardized terminologies, and the methods of coordination between the city and national and/or provincial governments.

3 **A TWO-PRONGED REGULATORY STRUCTURE: MAIN AND COMPLEMENTARY REGULATIONS**

The MSDI regulatory framework is structured in two parts.

- **The main city government decree for MSDI (or regulation applicable at the city government level) contains guiding principles for all key MSDI components, including the organizational structure relevant to the local context, roles and responsibilities of all stakeholders, standards for data management, building human resource competency, developing tools to support ease of data sharing and directives for implementation of all components.**

  While guiding principles are elucidated for all key components of MSDI, not all are regulated in the main city government regulation. Key components to be considered for the city government regulation are roles and responsibilities of all stakeholders, principles of data governance, data standards and data sharing, and directives for developing action plans including financial sustainability planning.

- **Subsequent complementary policies, regulations, procedures and guidelines should be considered to be developed in alignment with the umbrella IPDS framework of MSDI, based on city needs.**

4 GENERAL CONDITIONS OF THE REGULATION INCLUDES SETTING THE CONTEXT:

THE JURISDICTION THAT THE REGULATION APPLIES TO

The regulation provides the specific administrative boundary of the city government, within which the regulation is applicable.

CLEAR RESPONSIBILITIES FOR ENACTMENT OF THE REGULATION

It is suggested that the regulation is enacted through the highest level of authority binding upon the city government. It is mandatory to have Mayor's endorsement on the regulation along with other senior elected representatives and officials of the city government. For example, some cities use the form of a Mayoral Regulation to operationalize MSDI. In other cases where regulations applicable at city government level are framed at higher levels of the government (provincial or national), the regulation will be approved at the corresponding level. The MSDI regulations must specify these terms.

DEFINITIONS OF TERMINOLOGY

Terminology that qualifies urban data governance and management, defined in the regulation should bear alignment with national/ provincial level policies, where relevant. These set standards provide clarity to operationalize the regulation. Some terms (sample, not limited to) to be defined are Geospatial Data, Data Standards, Metadata, geoportal, Competency Framework, Strategic Workforce Plan, Fundamental Data Sets, Data Champions, Taskforce, etc. (see Chapter 1 for Commonly Used Terms and Definitions).

5   SCOPE OF MSDI REGULATIONS

- **Policy and strategy** for developing geospatial data to support accomplishment of city goals

- **Institutional arrangements**, including organizational structure and roles and responsibilities of stakeholders

- Mandates for developing **standards for data management, protocols for data sharing**

- Guidelines for building **human resources capacities**

- Provisions for launching **systems and technology** driven tools to facilitate data sharing

- **Partnerships and cooperation**

- Provisions for **financial planning**

- **Monitoring and Evaluation** of MSDI implementation

- **Incentives and disincentives**

- **Conflict resolution**

I. POLICY AND STRATEGY

The MSDI roadmap acts as policy and strategy for the city government to structure the activities pertaining to MSDI and enable data sharing to pursue evidence-led urban planning.

This section should:

- Stipulate the formulation of the MSDI roadmap through a collaborative process

- Lay out the Institutional Arrangements, People, Data, Systems (IPDS) framework as the foundational component to develop the roadmap

- Set the three horizon periods

- Provide a directive for updating the document along with specifying the review period.

The MSDI roadmap should be accompanied by a detailed action plan including cost estimates and schedule, provided through a separate document.

II. INSTITUTIONAL ARRANGEMENTS

Institutional arrangements are key to ensure the operationalization of MSDI. It comprises of the organizational structure, policies, regulations and protocols required to execute the MSDI activities.

- It provides directives (but are not limited to) how key stakeholders coordinate with one another for collection, production, processing, updating and maintenance of geospatial data relevant to planning and service delivery for the city.

- It also assigns responsibilities to stakeholders for developing appropriate data standards, norms for metadata, and compliance

with national and international standards, and identify and develop Fundamental Data Sets (FDS).

- Stakeholders responsible for managing and maintaining systems and technology led tools, such as geoportals are also defined through institutional arrangements.

- It also makes provisions for the creation of taskforces focused on priority challenges facing cities.

Executing activities pertaining to MSDI in a coherent and well-coordinated manner necessitates the creation of an MSDI Working Group (see Chapter 4 for further context).

Given this requirement, this section of the decree should include:

- **Functions of the MSDI working group**: including the general objectives of the working group.

- **A working model of the MSDI working group**. The MSDI working group can be voluntary or mandatory, based on the nature of the working environment in the city.

- **Organizational structure** of MSDI working group.

- **Principles for delineating roles and responsibilities** for each position/ stakeholder in the working group, including the MSDI Coordinator, Technical Coordinator, Data Champions, geoportal Taskforce, and other taskforces for addressing priority city issues.

- **Principles of establishing protocols for communication and coordination**

Details of roles and responsibilities for each position should be elaborated in a separate decree. These must be complemented by workflow mechanisms and communication protocols.

III. DATA MANAGEMENT

This section will explain the importance of compliance to data standards and metadata standards, FDS as key to effective and efficient geospatial data management. It lays out all elements of data management that the city government must establish. This includes:

- Definition of data standards, metadata, FDS

- Definitions of data classification

- Definition principles of data management across the life-cycle of geospatial data, including collection, processing, dissemination, maintenance, and updating of data

- Mandates for updating and maintenance of data

- Data assurance to ensure accurate and accountable data, to be executed by each agency

- Norms for data storage and hosting environment

- Mandates for developing a data access framework and data sharing, complemented by communication protocols.

Each component of data management stated above should align with and follow national and international standards. In several contexts, national and/or provincial governments may have set out guidelines for data management. City governments may elaborate on these and develop norms and processes specific to their context if required. These provisions are to be included in a separate regulation/decree/ guideline on data management, accompanying the main MSDI regulation.

Data Standards and Protocols are further described in the last section of this annex.

IV. PEOPLE

This section includes:

Geospatial competency framework

Norms for building geospatial competency in city government agencies are generally provided at the National and Provincial levels. Ideally, this regulation should have a clause on the directive for the city's geospatial competency framework. The main objective is to ensure the availability of geospatial manpower and to continuously sustain it. The provision for building geospatial competency may be accompanied in detail through a separate decree if required.

Capacity building

Through a set of principles, this section of the regulation highlights the need for building awareness of the importance of organizing geospatial information among stakeholders, and also the need for capacity building related to geospatial skills.

V. SYSTEM

This section will include:

- Mandates to establish a centralized geoportal that aligns with the network of national/ provincial geoportal nodes for cities as relevant

- Function of a geoportal, articulate the definition of processing geospatial data to be made available for data users as geospatial information

- Mandates to operationalize the geoportal, including:

    - Service Level Agreement for maintenance of the geoportal

○ Mandates for creating data backups to ensure data security and availability

○ Provisions for creation of a geoportal Working Group to administer its maintenance and quality, in alignment with roles and responsibilities delineated in the section on institutional arrangements

VI. PARTNERSHIP AND COOPERATION

This includes the articulation of an overarching principle that highlights benefits of partnership arrangements and cooperation between public agencies, academia and the private sector, in the long term to expand the creation and outreach of geospatial data across different user groups in society.

MSDI regulations thus need to make provisions that enable this objective. The regulation should include the purpose of establishing partnerships and cooperation between public agencies, academia and private sector and principles of mode of engagements.

VII. FINANCING

City governments often work with limited resources, posing challenges to implementation of planned activities pertaining to MSDI. It is important for the city government to allocate funding as an integral part of the city budget planning process, to operationalize and sustain activities of MSDI. This section stipulates the financial resource/obligation to mainstream budgets for MSDI activities.

VIII. MONITORING AND EVALUATION (M&E)

This section covers the mandate for the M&E framework of the city government, including the purpose of the framework for monitoring progress of implementation of planned MSDI activities and evaluation of outcomes. The framework has to be a

derivative of the MSDI roadmap (see Chapter 3 for further context). It should also define organizational responsibility for tracking MSDI implementation. The tool for M&E will be formulated through a separate document/decree.

IX. INCENTIVES AND DISINCENTIVES

Regulatory incentives can help to encourage city agency stakeholders to use geospatial data on a day-to-day basis to address challenges the city is facing with respect to service delivery. This section is optional based on the need and decision to introduce formal incentive mechanisms into the regulation.

Incentives for use of geospatial data may include rewards for stakeholders based on the accomplishment of Key Performance Indicators (KPIs) related to use of geospatial data to address city solutions. For example, the rewards could become an additional funding resource for upgrading different MSDI components at the city agencies, additional targeted capacity building in terms of geospatial skills, etc. On the other hand, disincentives for not adequately meeting targets may include departmental sanctions.

X. CONFLICT RESOLUTION

Provisions for conflict resolution has to be provided in the main MSDI regulation or included in an accompanying decree, as suited to the common practice in the local context. It includes provisions for arbitration and litigation.

An example is conflict related to dissemination of public information. Generally, it includes dissemination of public information that obstructs international relations and due process of law related to national and public safety and security, preservation of natural resources and assets, economic growth and privacy and needs to endorse respective national laws. Conflict may arise when the request of public information is rejected, periodical information is not provided, there is no response to information request or information provided is not as requested, there may be unreasonable charges of cost for information shared and provision of information exceeds the time limit regulated in respective national or provincial level laws and regulations.

PROVISIONS FOR DATA STANDARDS AND PROTOCOLS

Data standards and protocols are an important subset of the MSDI regulation, which governs the standard formatting of data, particularly spatial data, as well as the protocols by which agencies and the general public can acquire spatial data. Given the importance of this regulation in ensuring sustainable use of data by agencies, it should ideally be ratified in a format that will adequately enable implementation at the city level.

The following document outlines some of the major components and considerations which should be addressed when developing a regulation on MSDI data standards and protocols. While the components here are by no means exhaustive, this list is aimed to help MSDI delivery teams and city government counterparts to think about some of the aspects related to data standards and protocols to be considered when formulating such a regulation.

1   DATA DEFINITION

While basic in nature, proper definition of data, and more specifically spatial data, can go a long way to shape the efficacy of an MSDI. Clear definitions on spatial data, and data in general, can potentially help city officials understand the benefits and requirements of an MSDI regulation, or the use of geospatial data in general. Particularly in a developing country context, stakeholders may not be aware of the various characteristics that distinguish spatial data from other datasets, or machine-readable data and analog data. An agency may claim to have made 'data' available to other agencies, when the reality is they've only provided a map in jpg format, which an analyst will have to re-digitize at the expense of time, effort, and accuracy, before the data can be used. Clarifying these basic concepts right at

the beginning of a project, or better yet, in a regulation, can go a long way in ensuring smooth data analysis and exchanges across agencies. Some salient points are:

- **Distinction between analog and digital datasets**

- **Distinction between non-spatial and spatial datasets**[13]

- **Distinction between machine-readable and digitally accessible/human-readable datasets**[14]

- **Spatial data types – at a very minimum, this should recognize vector and raster spatial data models**[15]

USEFUL LINKS:

Machine readable definition from the Open Data Handbook: http://opendatahandbook.org/glossary/en/terms/machine-readable/

Raster and vector data distinction: Tidy Data: the Key to Success with Spatial Data (MEASURE Evaluation, University of North Carolina at Chapel Hill: https://www.measureevaluation.org/resources/publications/sr-17-142/at_download/document

To enable efficient communication and utilization of spatial datasets, it is important that the above definitions be thoroughly explained to stakeholders. This will also ensure the use of accurate language in the proposed MSDI data regulation.

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13   Non-spatial/ tabular datasets can sometimes still contain spatial information such as addresses, district names, or latitude/ longitude coordinates. This information can often help analysts 'spatialize' datasets by means of geocoding, or conducting spatial/ table join operations on these datasets. Considering the potential value of non-spatial datasets for an MSDI implementation, a regulation specifying the definition of 'spatial data' should be broad enough to still allow officials/ the target organization to leverage non-spatial datasets (Proposal for a Global Statistical Geospatial Framework).

14   Note that the appropriate machine readable format may differ by type of data. In the context of spatial datasets, a machine-readable raster data format may include GeoTIFF (Geostationary Earth Orbit Tagged Image File Format) data, while in the case of vector datasets, data may exist in a shapefile or GeoJSON format (a subset of JSON data: Geographic JavaScript Object Notation), among others

15   Source: MEASURE Evaluation, 2017."Frequently Asked Questions about Geographic Information Systems- Tidy Data: the Key to Success with Spatial Data https://www.measureevaluation.org/resources/publications/sr-17-142?searchterm=tidy+data+the+key+to+success

2 STANDARDS DEFINITION

The United Nations Global Geospatial Information Management (UN-GGIM) in its 2018 document defines standards to be: 'a documented agreement between providers and consumers, established by consensus that provides rules, guidelines, or characteristics ensuring that materials, products, and services are fit for purpose'[16]

In the context of MSDI and geospatial dataset utilization, **the introduction of geospatial data standards would enable easier data sharing, accessibility, and dissemination of geospatial data to different stakeholders**. It does so by setting a consistent format for data that enables greater data interoperability, which in turn translates to easier use of geospatial datasets by different stakeholder groups. Even before opening datasets from one agency, an analyst from another agency can be sure that the data will adhere to a certain agreed structure, both in terms of content (that it will contain the variables/ geographic features he/she needs) and format (that it will be available in a machine-readable format). This ensures that analyst can spend his/ her time optimally doing analysis, rather than searching for data and reformatting them to follow a certain structure/ format.

Given the aforementioned intent to enable easier data sharing and access, geospatial data standards can broadly be classified into two categories

- Content standards, which defines the semantics, content and structure of geographic information, so that geographic features and information can be located and represented consistently. This includes metadata[17] and data quality standards that would

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16   *Source: UN-GGIM, 2018. "A Guide to the Role of Standards in Geospatial Information Management, Version 2." http://ggim.un.org/meetings/GGIM-committee/8th-Session/documents/Standards_Guide_2018.pdf*

17 Metadata can be understood as data that describes the contents of data. In general, it contains basic information about the origins of the data: its name, date of collection, collecting agencies, quality, spatial information etc. Metadata standards can therefore be understood as a component of data standards which specifies standardized descriptions for documenting metadata

ensure that end-users always receive data of a consistent quality, therefore greatly enhancing the efficacy of geospatial data use.

- Technology standards, which define formats and interfaces, such as Application Programming Interfaces (APIs) and services, which allow different systems and services to work together seamlessly[18]

Note that standards documents from national governments and international organizations such as the International Standards Organization (ISO) may be very technical in nature, and cities may not always be familiar with these types of documents. Given this, it may be necessary to start off an MSDI data regulation with a definition of standards, its purpose, and the benefits of its implementation. The involvement of an MSDI Technical Coordinator, and perhaps a local expert on data standards, is integral in the introduction of spatial data standards to other stakeholders, and the formulation of the standards to be applied in the city.

USEFUL LINKS:

A Guide to the Role of Standards in Geospatial Information Management (UN-GGIM): http://ggim.un.org/meetings/GGIM-committee/8th-Session/documents/Standards_Guide_2018.pdf

3 DATA STANDARDS

As outlined in the previous section, data standards have the potential to enhance the interoperability and wider use of geospatial data, and data in general. However, one thing to consider in introducing data standards is that there are bound to be existing standards at the national level. Additionally, there are international organizations that have developed international standards for geospatial data, such as the International Standards Organization (ISO) and Open Geospatial

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18 Source: A Guide to the Role of Standards in Geospatial Information Management

BOX 8: OTHER CONSIDERATIONS: GEOSPATIAL DATA STANDARDIZATION WORK PLAN

In some contexts, where geospatial data use and standards have yet to mature, it is likely that there will be gaps in technical understanding that is often required to implement these standards in cities. This may mean that it will be impossible to apply standards at the same time. As such, a standardization work plan, led by a committee such as the MSDI Working Group and its Technical Coordinator, will need to be formulated prior to the introduction of these standards. Broadly, the work of this committee may cover the following:

1. Planning, which includes the prioritization of Fundamental Datasets for standardization and documentation of standards and Standard Operating Procedures (SOPs)

2. Implementation of standards

3. Review of standards and SOPs

Phases (1) and (2) should be based on priority sectors' needs and KPIs identified through other MSDI-related sub-committees. Given the very technical nature of this exercise, it may be necessary to procure the services of a consultant/ firm that is familiar with these standards, and is able to translate this into policy recommendations.

Consortium (OGC). The development of a geospatial data standards must therefore observe these resources at a minimum, in order to ensure both technical and legal interoperability of datasets between the various levels of governments and organizations.Existing national standards[19]

- International data standards from the following organizations, among others:

  - International Organization for Standardization (ISO) Technical Committee 211 Geographic Information/ Geomatics (ISO/ TC 211)

  - Open Geospatial Consortium (OGC)

  - International Hydrographic Organization (IHO)

There is an extensive list for geospatial data standards, and it may not be possible to include all of them in one regulation. However, a regulation on geospatial data standards should broadly cover the following aspects[20]:

- Standards for geospatial dataset schemas – specifying the way that spatial features are represented (as points, lines, polygons, up to 3D objects, and their topology).

- Quality of geospatial datasets Spatial Data Quality Assessment in GIS- according to the ISO 19113 standards, geospatial data quality is determined by its completeness, logical consistency, positional

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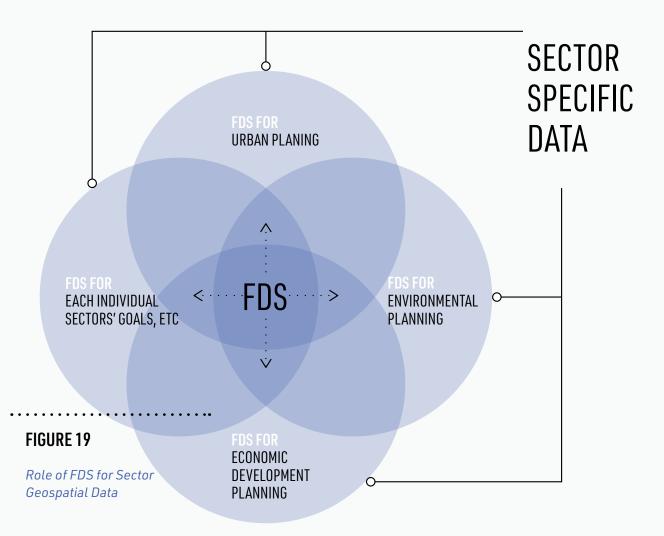
19 While it is important to observe both existing national and local standards when developing an MSDI data standards and protocols, in an environment where MSDI has yet to mature, it will often be the case that geospatial data standards are either too broad or too rigid. In circumstances where geospatial data standards are relatively rigid, the MSDI delivery team should try to explore other possible avenues of implementing data standards and conducting analysis using geospatial data. These may include the use of open-source data

20   Source: Guidelines of Best Practice for the Acquisition, Storage, Maintenance and Dissemination of Fundamental Geo-Spatial Datasets; available at: http://sdistandards.icaci.org/wp-content/uploads/2014/10/MAfA_SectionC_ Integrated_V10.pdf

temporal, and thematic accuracy. Teams and cities are encouraged to think about these five elements to determine a standard for quality of geospatial datasets. Refer to Spatial Data Quality Assessment in GIS for further details.

- Acquisition of geospatial datasets – in order for datasets to be interoperable, specifications to make interoperable datasets should be specified; its terminology, metadata, and surveying elements. A sample of these can be seen in Standardization of Geographic Information, page 119-120.

- Storage of geospatial datasets – a standardized storage format for geospatial data can provide an analyst with a consistent way to search and use spatial data. This standard will be relevant to determine how agencies can store their data, possibly in the geoportal's database.

- Dissemination of geospatial datasets – linked to the above, see Companion document on Standards Recommendations by Tier for a summary of the most popular standards (particularly those on Web Map Services (WMS) and Keyhole Markup Language(KML)) – this will be relevant for when agencies decide to share their data over the web, possibly via the geoportal.

- Maintenance of geospatial datasets –in order for data to stay relevant, datasets will need to be continuously maintained. This maintenance process can vary, and cities should ideally determine a Service Level Agreement (SLA) that is manageable, based on the resources they have. For an example of the things that teams may wish to consider, in determining this SLA, see National Geospatial Digital Archive (NGDA) Lifecycle Maturity Assessment Dashboard.

SECTOR SPECIFIC DATA

FDS FOR URBAN PLANING

FDS FOR EACH INDIVIDUAL SECTORS' GOALS, ETC

FDS

FDS FOR ENVIRONMENTAL PLANNING

FDS FOR ECONOMIC DEVELOPMENT PLANNING

FIGURE 19

Role of FDS for Sector Geospatial Data

USEFUL LINKS:

Guidelines of Best Practice for the Acquisition, Storage, Maintenance and Dissemination of Fundamental Geo-Spatial Datasets: http://sdistandards.icaci.org/wp-content/uploads/2014/10/MAfA_SectionC_Integrated_V10.pdf (see last page for a list of all relevant standards)

NGDA (Data) Lifecycle Maturity Assessment Dashboard: https://dashboard.geoplatform.gov/lma?assessments=2017

A Guide to the Role of Standards in Geospatial Information Management (UN-GGIM): http://ggim.un.org/meetings/GGIM-committee/8th-Session/documents/Standards_Guide_2018.pdf

4 FUNDAMENTAL DATA SETS (FDS)

One of the characteristics of a geospatial dataset is that it must have a spatial reference that would enable it to be geographically 'stacked' in alignment to another. The most conventional method to produce new geospatial dataset is to reference an existing geospatial dataset, and manually trace (digitize) new datasets from an existing one (usually an orthorectified satellite/ aerial imagery). The primary purpose of FDS is to serve as the reference for this process (including the more modern version of this process), and therefore encourage the production of new geospatial data.

Drawing from various literature and research[21], CPL further defines FDS as datasets that possess the following characteristics:

1. It cannot (or is difficult to) derive from other datasets. Instead, **it serves as a basis and spatial reference for the production of other spatial datasets**

2. An FDS should represent the **lowest common denominator of data requirements for all sectors**, or a common intersection of all agencies' data requirements

3. It is important for the realization of all planning goals, regardless of sectors. This also implies that **conceptually, an FDS should be generic in nature, rather than being sector-specific**

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21 Note that no single definition or terminologies has been developed yet for a Fundamental Data Set (FDS). UN-GGIM and the GSDI refers to an FDS as 'Core Data', whereas the United Nations Economic Commission for Africa (UNECA) refers to it as 'Fundamental Data Set'. The Australia New Zealand Land Information Council (ANZLIC) and the United States also possess their own definitions for this topic'. The definition of FDS outlined in this document was essentially derived from the intersection between the various definition of an FDS by all these agencies.

Given an FDS's capability to serve as the basis for the production of other geospatial data, it can be concluded that an FDS also has the potential to expedite the process of spatial data production in cities. It does so by allowing target organizations to selectively prioritize the production of spatial datasets which could subsequently serve as the foundation for producing other spatial datasets.

However, much like the case of 'data standards', there may already be an existing list of FDS that is developed at the national level. An effort to develop a list of FDS should therefore pay attention to existing FDS lists. Additionally, it may also be possible that target organizations do not possess the capacity nor resource to develop identified spatial datasets. In such situations, MSDI delivery teams and stakeholders should first prioritize the development of a subset of the FDS that aligns with the organization's priority sectors[22].

USEFUL LINKS:

For further clarity on the distinction of Fundamental Data Sets and the typical priority geospatial dataset, see the following presentation on the distinction of the Infrastructure for Spatial Information in Europe, (INSPIRE) and Geospatial Core Dataset: https://inspire.ec.europa.eu/sites/default/files/presentations/0945_isn.18.095_faq_core_data_inspire-v1.pdf

Determination of Fundamental Datasets for Africa (UNECA): https://www.uneca.org/sites/default/files/PublicationFiles/geoinformation_socio_economic_dev-en.pdf

Core Data Scope (UN-GGIM): http://un-ggim-europe.org/sites/default/files/UN-GGIM-Europe%20WGA%20Core_Data_Scope-v1.2.pdf

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22   The standards for determining which geospatial data should be included in the list of FDS are an open debate. Even when a standard FDS list has been released in a particular context, there may still be disagreements on this list of FDS. However, given its potential to enable further geospatial data production and analysis, teams are encouraged to anchor their analysis on the list that they and their counterpart agreed on, to anchor their FDS collection efforts.

5 DATA ACCESS PROTOCOLS

Data access protocols should primarily regulate the methods by which data can be transferred and received. This part should not be confused with 'standards' which regulates the technological standards that defines interfaces such as Application Program Interfaces (APIs) and services. Rather, this section should address the governance aspects of data transfers and usage. Ultimately, the primary goals of this section is to 1) enable data sharing, and 2) to address the legal concerns that may come from the sharing of geospatial data. As such, data governance should ideally address the following broad components:

- **Geospatial data usage policies**

- **Types and levels of data confidentiality**

- **Data consumer classification and definition**

- **Data access protocols/ framework**

Relevant items to be considered from each of the individual components above are listed below:

GEOSPATIAL DATA USAGE POLICIES

This component should establish the principles, responsibilities, and requirements for using geospatial data and services. Some restrictions may be imposed on the use and sharing of geospatial datasets to address concerns regarding the appropriate use and interpretation of data, concerns about unintended consequences of sharing data, accidental release of sensitive data, or adherence to other regulations/ legislation. Methods that may be used to address these concerns includes: access controls, security and privacy policies, or security standards in developing geospatial information, among others[23].

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23   *Source: Bertino et al, 2008. "Security and Privacy for Geospatial Data: Concepts and Research Direction". https://dl.acm.org/citation.cfm?id=1503406*

DATA ACCESS AND SHARING - GOOD PRACTICES
(E.G. GUIDELINES IN MAYORAL DECREE)

For Data Access and Sharing, below are the proposed good practices (adapted from ANZLIC, 2014):

Principle 1: Data will be open-by default unless access is restricted for reasons of privacy, public safety, security, confidentiality, and compliance with law.

Principle 2: Data will preferably be made available under open licensing framework.

Principle 3: Data will be made available at no or minimal cost, with limited exceptions.

Principle 4: Data will be easy to find (discoverable) and accessible in formats that promote its reuse.

Principle 5: Government will follow standards and guidelines relating to release of data and agency accountability for that release.

DATA ACCESS FRAMEWORK	DEFINITION	EXAMPLES FOR CONSIDERATION
OPEN	The unauthorized disclosure, alteration or destruction of the date would result in little or no risk to the government	• A. Census data • B. Points-of-interests: tourists spots, location of public facilities (e.g. clinics, parks, schools) and government offices (police, mayor's office) • C. Basemap: building outline, road networks
RESTRICTED	The unauthorized disclosure, alteration or destruction of the data could result in a moderate level of risk to the government. A reasonable level of security controls should be applied to Restricted data.	• A. Administrative city infrastructure: e.g. detailed building information (suich as tenure, age, height) • B. Aggregated demographic information
CLASSIFIED	The unauthorized disclosure, alteration or destruction of the data could result in a significant level of risk to the government. A high level of security controls should be applied to Confidential data.	• A. Critical city infrastructure: e.g. sewerage and water lines, telco lines • B. Granular demographic information: e.g. no. of residents by housing unit
SECRET	The unauthorized disclosure, alteration or destruction of the data could result in a severe and catastrophic effecy of risk to the government. The highest level of security controls should be applied to Secret data.	• Generally datasets that concern with national security (e.g. exact location of military facilities) and personal identifiable information (citizens' names, identity number, personal health conditions)

TYPES AND LEVELS OF DATA CONFIDENTIALITY

An outline of the levels of confidentiality of datasets and the legal obligations that is associated with them. These should be accompanied by an identification of the criteria for data belonging to each of the categories (see Figure 20 for further context). The process to determine the levels of confidentiality of datasets in the target organization may include the following steps:

1. Determine and share the city's inventory of datasets, their metadata and data access classification as a baseline for data sharing.

2. Adopt a consultative approach when resolving technical and policy challenges. For example, while the data owner determines the data classification for its own dataset, the MSDI Working Group can collectively build consensus and consistency in classifying datasets across the city.

3. If there is a need for arbitration, the MSDI Coordinator can raise these issues to the Mayor for a decision.

DATA CONSUMER CLASSIFICATION AND DEFINITION

This aspect refers to the identification of potential institutions that may access and use datasets, as well as the level of privileges for each data consumer class.

For example, a recent research on the legal aspects of access to geo-information within the Indonesian SDI recommends the categorization of data users into public institutions, private institutions, and educational institutions[24]. Note that since the regulation on data access and protocols is a subsidiary of an overall MSDI regulation, the classification and definition of consumer/ user groups may need to refer to the overall MSDI regulation, where applicable. These may include particular data custodians, private entities, or collaborating academic institutions.
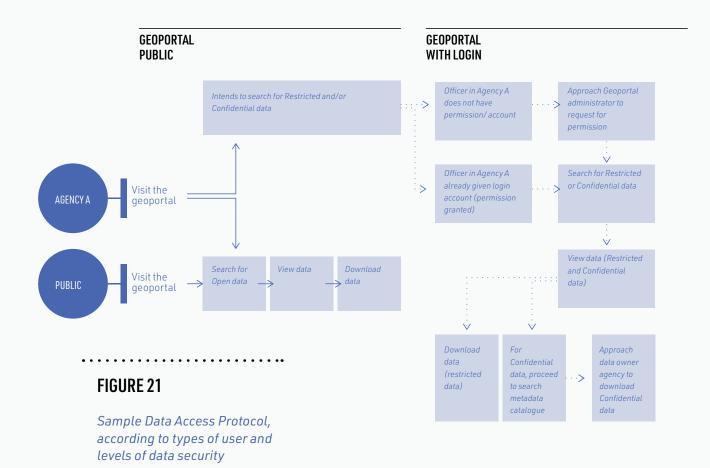
Upon identification of the desired user types and data categories, cities and MSDI delivery teams may wish to map the two basic components of data sharing together, to inform the development of data access protocols in the next section of the regulation.

DATA ACCESS PROTOCOLS/ FRAMEWORK

Upon establishment of data confidentiality, user/ consumer of geospatial data classes, and their relationships, the next step is to establish a data access protocol. This should outline the steps/ procedures that users from a particular consumer class needs to undertake, in order to gain access to geospatial data. Similar to the previous point, the definition of data access protocol/ framework should be aligned with the roles and responsibilities that have been established in the overall MSDI regulation.

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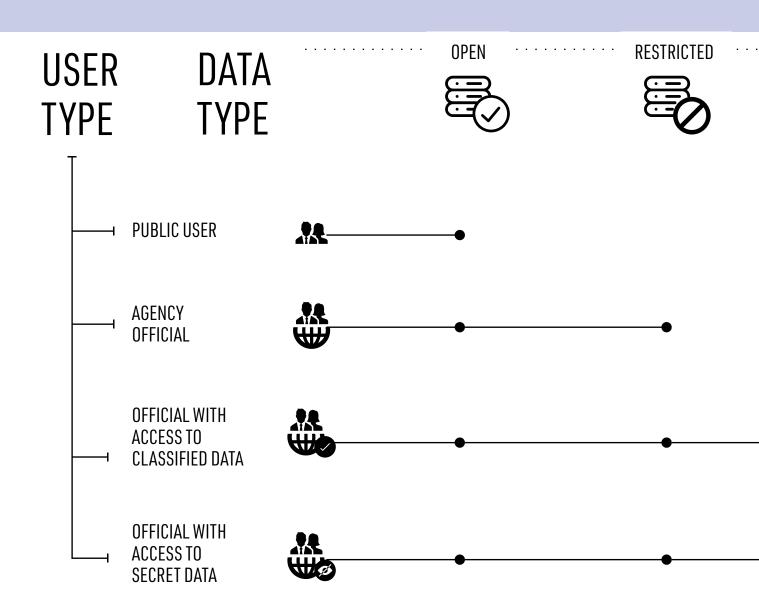
24   *Source: Abdulharis et al. "Legal Aspects of Access to Geo-Information Within Indonesian Spatial Data Infrastructure". https://www.isprs.org/PROCEEDINGS/XXXVI/4-W6/papers/147-154RizqiAbdulharis-A078.pdf*

A sample data access protocol framework that shows the steps of accessing data is shown below:

GEOPORTAL PUBLIC

GEOPORTAL WITH LOGIN

Intends to search for Restricted and/or Confidential data

Officer in Agency A does not have permission/ account

Approach Geoportal administrator to request for permission

AGENCY A — Visit the geoportal

Officer in Agency A already given login account (permission granted)

Search for Restricted or Confidential data

PUBLIC — Visit the geoportal

Search for Open data

View data

Download data

View data (Restricted and Confidential data)

Download data (restricted data)

For Confidential data, proceed to search metadata catalogue

Approach data owner agency to download Confidential data

FIGURE 21

Sample Data Access Protocol, according to types of user and levels of data security

USEFUL LINKS:

Legal Aspects of Access to Geo-Information within Indonesian Spatial Data Infrastructure: https://www.isprs.org/PROCEEDINGS/XXXVI/4-W6/papers/147-154RizqiAbdulharis-A078.pdf

USER TYPE

DATA TYPE

OPEN   RESTRICTED

PUBLIC USER

AGENCY OFFICIAL

OFFICIAL WITH ACCESS TO CLASSIFIED DATA

OFFICIAL WITH ACCESS TO SECRET DATA

BOX 9: MAPPING OF USER TYPES AGAINST DATA CONSUMER CLASS

The purpose of the next section on 'Data access protocols/ framework' is to technically define the manner by which a potential data consumer can access information on geospatial data, based on the consumer's user category and the data's level of security. While a specialist will most likely be involved in developing the actual web platform that allows for data to be disseminated, the way, form, and procedure to obtain this data is

CLASSIFIED · · · · · · · · SECRET

defined the user categories and levels of data security, an MSDI delivery team could then propose a non-technical exercise to map out the desired relationship between potential users and geospatial data. An example mapping of this relationship, based on the sample user categories and levels of data security outlined in this document, can be seen in Figure xx.

While performing this mapping exercise, teams and their counterparts may also wish to revisit their definition of user and data classes, the responsibilities associated with each user and data classes, the platform in which data can be accessed, among others. As officials revisit their definitions, more mapping exercises can further refine the desired relationship between users and the data that city has. This map will subsequently be translated into a formal data access protocols/ framework, which will be reflected in the city's chosen geospatial data distribution platform (ideally a geoportal).

still defined by the user's requirements and policies (in this case, cities, with inputs from the MSDI delivery team).

As such, it is important to clearly communicate these requirements to the specialist who will be building the web platform. Having

ANNEX 3

MSDI DELIVERY TEAM COMPETENCIES

MSDI DELIVERY TEAM COMPETENCIES

MSDI DELIVERY TEAM ORGANIZATION

The organization of an MSDI design and delivery team is important for its implementation and correlates strongly with the 'People' component the MSDI-IPDS framework . **Operationalizing MSDI includes performing a diverse array of sub-tasks, which require different types of skills and expertise. These may range from business-related skills such as policymaking and governance, management, facilitation and human resourcing, to skills that are more technical in nature: geospatial analysis and data analysis, as well as Information Technology** (as outlined in the document: Workforce Development Models for Geospatial Technology). Thus, in order to design an MSDI Implementation Roadmap and initiate the activities that correspond to its individual IPDS pillars, consultant firms and individuals within the MSDI delivery team will require competencies that cut across all these aspects.

There have been many attempts to identify these competencies and map them into roles that are needed to leverage geospatial information (as outlined in the document: Workforce Development Models for Geospatial Technology, 2001; the Urban and Regional Information Systems Association -URISA, 2006). A notable early effort to do so in the United States was initiated by the University of Southern Mississippi in 2001, which identified 12 geospatial roles. This was subsequently revised by the issuance of the Geospatial Technology Competency Model (GTCM) in 2014. Other SDI implementation efforts have
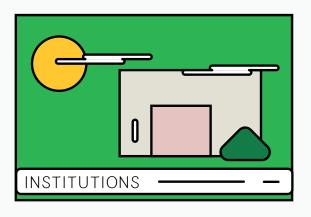
also recognized the importance of having the right competencies and workforce to support an SDI (as outlined in the document: GTCM, 2016, National Academy of Sciences, 2012).

Building on these previous attempts, and its own experience in implementing MSDI in Indonesia, CPL proposes a list of MSDI Competencies for the delivery team to account for in the development of MSDI (classified into four broad categories in line with the IPDS framework). It is to be noted that the competencies listed reference senior level positions across all pillars. This is because:

(i) If the MSDI delivery team is resource constrained, they can start by engaging senior experts who can set the strategic direction and kickstart the various initiatives. This can be followed by mid to junior-level hires

to complete the team composition when resources are available.

(ii) In cases where resource is not a constraint, it is assumed that the senior leads will identify a team of mid to junior-level staff to cover various aspects of the project delivery.

Further, there may also be instances where one individual may have skillsets that span two or more than two roles. In which cases, a strategic decision must be reached to minimize duplication and use the individual across needs of multiple roles. For the sake of simplicity, this document highlights required competencies for every role in a discrete manner.

INSTITUTIONAL ARRANGEMENTS

Activities under the Institutional Arrangements pillar aim to **enhance inter-agency collaboration, along with regulations and organizational structures for streamlining the use of geospatial data, facilitating systematic data sharing and data management**. Working in conjunction with city governments, the consultants working on this aspect of MSDI will need to assist them in drafting a suite of mayoral decrees, data protocols, roles and responsibilities for all relevant stakeholders, and inter-agency service level agreements.
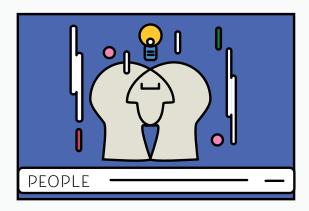
Another substantial part of the work related to the Institutional Arrangements will be the development of an **MSDI implementation roadmap**. This process will be largely driven by the targeted city's existing priorities, its regulatory and organizational environment, as well as relevant international standards and best practices. Considering the nature

of work in this component, it is desirable to procure the services of a consultant/ vendor who is familiar with both the regulatory and institutional environment surrounding the target organization, as well as international geospatial data standards and MSDI best practices. This should then be complemented by knowledge of national, provincial and city regulatory frameworks, which may be procured through collaboration with local experts.

MSDI Regulations and organizational structures are only useful if they can be implemented effectively with consensus from all stakeholders. Thus, the consultants in charge of the Institutional Arrangements aspect must also include facilitation of meeting and conducting workshops as part of their responsibility.

| NO.	KEY PERSONNEL	QUALIFICATIONS
1	Senior MSDI Expert	• Post-graduate degree in relevant spatial science discipline such as geodesy, geodetics, geography, urban planning, IT, or other relevant disciplines • At least 10 years of designing and delivering SDI projects • Knowledge of and experience in legal matters related to establishing MSDI, covering both the regulatory and institutional aspects • Ability to conduct policy dialog with relevant stakeholders • Knowledge and experience of ICT aspects related to establishing an SDI, or eGovernment implementation/ consultancy • Proven experience in working on SDI establishment projects, including cross-cutting knowledge of relevant IPDS systems • Proven experience in leading multi-stakeholder policy discussions and workshops pertaining to the establishment of SDIs in developing country context
2	Senior Facilitator/ Trainer	• Advanced academic degree, preferably in a relevant discipline • At least 5 years of experience in designing and facilitating collaborative workshops • Proven knowledge and experience in innovative collaborative workshop facilitation methods (to enable inter-agency facilitation and communication; experience in devising effective modalities for developing country contexts is desirable) • Knowledge of SDI and geospatial analysis is advantageous

PEOPLE
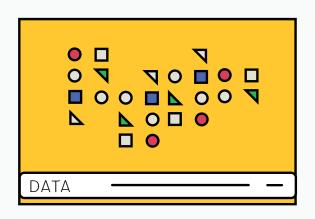
In the initial MSDI implementation phase, individuals working on the People component of MSDI will mainly be needed to conduct two activities. **The first is to contribute to the development of capacity building modules, lead technical workshops relating to SDI and build awareness as well as technical capabilities of city agencies to start utilizing geospatial data. The second activity consists of technical facilitation including facilitating meetings across stakeholders to arrive at a consensus on a common base map to be referenced in spatial data production, data formats, metadata standards, among others**. Given the nature of the activities, it may be necessary to procure the services of at least two different consultants/vendors to address both of the activities.

The responsibilities of consultants addressing the people component of MSDI may also be expanded to also cover the development of a geospatial competency framework. The development of such framework will enable target cities to create a geospatial workforce plan, and ensure that there is a competent pool of staff who can execute the various activities of MSDI in a sustainable manner.[25] The list of positions and qualifications of consultants that are relevant for purposes of delivering the activities related to the People component of MSDI are described in the table to the right:

25   National Research Council, 2013.Future US Workforce for Geospatial Intelligence. Washington, DC: The National Academies Press. https://doi.org/10.17226/18265

NO.	KEY PERSONNEL	QUALIFICATIONS
1	Capacity Building Team Leader	• Advanced academic degree/ master's degree in Geography/ Urban Planning/ Geo-engineering, or other relevant disciplines • At least 10-15 years of experience in establishing geospatial data infrastructures and overall spatial analysis using GIS (ArcGIS/ QGIS/ MapInfo etc.) • Proven experience of working as a GIS instructor; specific experience in the developing country context desirable • Proven experience in analyzing, designing and developing modules and training programs for the purposes of geospatial knowledge transfer • Proven ability to perform geospatial and data analysis tasks using algorithmic approaches and appropriate tools, such as Python and R programming languages or other equivalent instruments
3	Technical Facilitator/ Trainer	• Advanced academic degree in a relevant discipline • At least 5 years of experience in designing and facilitating collaborative workshops • Proven knowledge and experience of innovative collaborative workshop facilitation principles to enable effective communication of complex technical concepts • Proven knowledge of SDI, geospatial analysis, and relevant international SDI and geospatial data standards

DATA
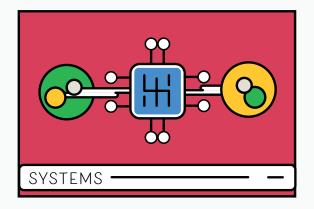
Effective use of geospatial data helps establish a business case for investment in MSDI by demonstrating the benefits and raising awareness as to how evidence-driven planning can enhance the efficacy of existing processes. The data pillar of the IPDS framework is a critical component to enable this. For instance, using geospatial data to analyze and target interventions to flood-prone areas in a city (instead of adopting ad-hoc or temporary measures) can demonstrate the effective use of data in the day-to-day tasks of relevant city agencies.

Skills related to the data pillar includes, among others, geodesy and spatial data collection, remote sensing, cartography, data analysis, GIS and spatial econometrics. Covering the spectrum of the benefits of geospatial analysis requires a very diverse set of skills which may

be difficult to possess, especially in early stages of MSDI development. In this context, **it is advised that the MSDI delivery team focus on procuring skills that would allow for either: a) broad utilization of geospatial datasets, or b) alignment with the city's priority sectors**. For example if the goal is to ensure broad utilization of geospatial datasets, key personnel (1) and (2) from the table below would be required. If alignment with city's priority sectors is critical, then it would be important to bring on board a resource with skillsets specified for key personnel (3), in addition to (1) and (2) listed below.

NO.	KEY PERSONNEL	QUALIFICATIONS
1	Senior GIS Expert and Data Analyst	• Advanced academic degree/ master's degree in Geography/ GIS/ Urban Planning/ Geo-engineering/ Statistics/ Computer Science/ Information Systems, or other relevant disciplines • At least 10 years of experience of conducting geospatial analysis using GIS (ArcGIS/ QGIS/ MapInfo etc.) and statistical approaches • Proven ability to performing geospatial data cleaning and analysis tasks using algorithmic approaches and appropriate tools, such as Python, R, or other equivalent instruments • Knowledge of advanced statistical concepts and analysis, as well as machine-learning algorithms and other advanced geospatial data analytics methods to inform decision making, generate analysis, or draw conclusions
2	Senior Geospatial Data Visualization Expert	• Advanced academic degree/ master's degree in Geography/ GIS/ Urban Planning/ Geo-engineering/ Cartography/ Computer Science/ Information Systems, or other relevant disciplines • At least 10 years of experience of conducting geospatial analysis using GIS (ArcGIS/ QGIS/ MapInfo etc.) • Proven ability to visualize spatial datasets to communicate concepts, findings and information using various presentation methods (e.g.: chloropleth maps, heat maps, cluster maps, etc.) • Ability to render spatial data and information into interactive geospatial visualization using relevant programming tools (i.e.: R, Python, Leaflet, or other tools/ instruments) desirable
3	Senior Geospatial Data Acquisition Expert	• Advanced academic degree/ master's degree in Geography, Geo-engineering or other relevant disciplines • At least 10 years of experience of conducting geospatial analysis using GIS (ArcGIS/ QGIS/ MapInfo, etc) • At least 8-10 years of experience in performing geospatial data collection by means of traditional land-based surveying, as well as advanced data collection methods (i.e.: GPS data collection, remote sensing, LIDAR terrain mapping, among others) • Proven experience of remote sensing, interpretation of geospatial data from various imaging systems, and performing geospatial data quality assurances • Proven knowledge and ability to correct and process raw geospatial data (i.e.: satellite or aerial imageries, GPS data) into ready-to-use geospatial data products

SYSTEMS

maintenance processes so as to ensure smooth handover of the geoportal from the developers of the system (consulting firm could be a local or international firm, or a combination of both) to the city.

In order to mainstream the use of MSDI across city agencies, **it is necessary to establish a system that can serve as a platform for geospatial data and resource exchanges, inter-agency collaboration, and the obtaining of geospatial information to support decision-making purposes.** A geoportal can serve as a platform to accommodate the aforementioned needs[26]. The tasks associated with the 'Systems' component of an MSDI implementation framework are therefore largely concerned with the establishment of a geoportal. This is also complemented by routine maintenance tasks, in parallel with capacity building workshops on the

In many cases, there are already established international standards and applications that address the technical requirements for geospatial data storage, dissemination and display[27]. Additionally, given that a geoportal would typically need to be hosted in either the relevant agency's server environment or the cloud, developers of the system should also be able to identify the appropriate hardware/software components required to host it, and advise the client on the costs and benefits of alternative hosting environments. As such, the relevant qualifications for key professionals that would enable the implementation of the geoportal should, at a minimum include:

26   *Maguire and Longley, 2005. "The Emergence of geoportals and Their Role in Spatial Data Infrastructures" https://www.sciencedirect.com/science/article/pii/S0198971504000456*

27   *Many of the relevant standards concerning geospatial data and its components are developed by the International Standards Organization (ISO). Some notable examples of these standards includes: ISO 19115:2003 on Metadata standards, or ISO 19128:2005 on the presentation of geographic information via a Web Map Server (WMS). Additional standards are also developed by international geospatial organizations, such as the Open Geospatial Consortium (OGC)*

NO.	KEY PERSONNEL	QUALIFICATIONS
1	Geoportal Implementation Team Leader	• Advanced academic degree/ master's degree in Geography/ Urban Planning/ Geo-engineering, or other relevant disciplines • At least 10-15 years of experience of design, development, delivery and maintenance of geoportals • Familiarity with relevant ISO and OGC geospatial data standards is mandatory • Proven experience in working in an Information and Communications Technology (ICT) environment; experience working in developing countries desirable • Proven ability to assess requirements for system capacities including inputs, outputs, processes, timing and performance, as well as recommend necessary additions or adaptations
2	Senior Geospatial Data Visualization Expert	• Advanced academic degree/ master's degree in geography/ urban planning/ geo-engineering • At least 10 years of experience of design, development and maintenance of geoportals • Proven experience of working in an ICT environment in developing countries; experience working in developing countries desirable • Familiarity with relevant ISO and OGC geospatial data standards is mandatory • Proven ability to process geospatial data and extract information to create analysis, drive conclusions, and inform decision making reports
3	Senior Geospatial Data Acquisition Expert	• Advanced academic degree in the domain of Information and Communications Technology (ICT) • At least 10 years of experience of identifying and developing geospatial tools and instruments (including GIS web services) to satisfy customer needs • Proven experience of developing centralized geoportals for city governments in developing countries • Prior knowledge of relevant ISO and OGC geographic web-service and data storage standards is advantageous • Proven ability to assess requirements for system capacities including inputs, outputs, processes, timing and performance, as well as recommend necessary additions or adaptations

NO.	KEY PERSONNEL	QUALIFICATIONS
4	Senior Geospatial Database Architect	• Advanced academic degree in the domain of Information and Communications Technology (ICT) • At least 10 years of experience of managing databases and server environments. • Proven experience of developing geoportals for city governments, including launch, operations, maintenance, as well as systems and data updating processes; • Experience of working in developing countries desirable • Proven ability to design the cataloging, archiving, retrieval, and distribution system of geospatial data • Prior knowledge of relevant ISO and OGC geographic web-service and data storage standards is advantageous • Proven ability to integrate resources and develop additional resources to support spatial and temporal user requirements

NOTE

It should be noted that the above qualifications outlined mainly refer to the specialist qualifications for consultants and stakeholders. In order to ensure that activities pertaining to the individual pillars of MSDI can be delivered on time and within budget, general business competencies such as project management, effective communication, and collaboration should still be exemplified by the individuals/ firms from which the above services are to be procured.

ANNEX 4
QUESTIONNAIRES

QUESTIONNAIRES

RAPID MSDI READINESS ASSESSMENT

Please rate the level of implementation of each variable in your agency or city, by ticking the relevant box for each variable.

The survey is designed to be completed by decision-maker level officials, to give them a quick overview of the status of their IPDS enabling components. The survey utilizes a five point Likert-type scale, to rate the responses of city officials from very low to very high. These responses are then converted into quantitative values, following the conversion table in Figure 22.

FIGURE 22

Conversion table for Rapid MSDI Assessment Survey

RESPONSES	ASSOCIATED SCORE
Very Low (VL)	0
Low (L)	0.25
Average (A)	0.5
High (H)	0.75
Very High (VH)	1.0

FACTOR	VARIABLE	VERY LOW	LOW	AVERAGE	HIGH	VERY HIGH
INSTITUTIONAL ARRANGEMENTS	Government central funding					
	Data policy aimed to return on investment					
	Private sector and academia involvement					
	Legal framework from SDI strategy, and access to information					
PEOPLE	Human capital					
	Spatial data education					
	Individual leadership					
DATA	Digital cartography availability					
	Metadata availability					
	Data standards					
SYSTEMS	Web connectivity and Telecommunication Infrastructure					
	Access to web mapping					
	Geospatial software					
	Own development / open source					

Using the above conversion table, the team administering the survey can then convert all of the participants' responses into quantitative values, which can then be used to calculate the overall score of each enabler. See the following table for an example of how this can be done:

	INSTITUTIONAL				PEOPLE			DATA			SYSTEMS			
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14
Participant A	VL	H	L	H	VL	A	A	A	VH	VL	L	A	H	H
Participant B	L	A	L	H	L	L	L	A	VH	VL	L	A	H	H
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Participant Z														

Following the conversion table for rapid MSDI assessment (Figure 22), the qualitative responses of officials can then be converted into its quantitative form:

	INSTITUTIONAL				PEOPLE			DATA			SYSTEMS			
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14
Participant A	0	0.75	0.25	0.75	0	0.5	0.5	0.5	1	0	0.25	0.5	0.75	0.75
Participant B	0.25	0.5	0.25	0.75	0.25	0.25	0.25	0.5	1	0	0.25	0.5	0.75	0.75
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Participant Z														

A final score for each of the individual IPDS enabling components can then be calculated by averaging the scores that have been entered by the participants, for each of the individual enabling components.

The readiness score of a framework pillar (e.g. Institutional Arrangements) is then calculated by averaging the score of individual enablers that make up the pillar. Finally, the city's overall **MSDI Readiness Index** is obtained by averaging the values across all framework pillars.

The method is designed to help decision makers develop a common understanding of the current status of the city's MSDI readiness across the IPDS enabling components.

Note:
- Q1-12 in the sample table corresponds to each of the 12 questions in the Rapid MSDI Assessment table.
- The values VL/L/A/H/VH corresponds to all the possible responses that officials may put in the Rapid MSDI Assessment survey: Very Low/ Low/ Average/ High/ Very High.

GEOSPATIAL PRIORITIZATION SURVEY

The survey aims to measure current performance of city services and quality of life. Indicators cover broad sectors of urban services and are underpinned by an integrated approach to sustainable development and resilience. They aim to help city senior management and urban planners track progress on city performance and set appropriate targets.

The sectors used in the survey are described on the next page.

SECTOR	DESCRIPTION
Economy	*Economic health and manpower, such as employment rate, poverty rate.*
Education	*Educational opportunities, such as student enrolment, student/teacher ratio, completion of primary and secondary education, prevalence of higher education degrees.*
Energy	*Efficiency of electricity production and consumption, such as electrical energy use per capita, use of renewable sources.*
Environment	*Environmental quality and biodiversity conservation, such as atmospheric concentrations of Particulate Matter, noise pollution, health of native species.*
Finance	*Financial management, such as debt service ratio, capital spending, own-source revenue as a percentage of total revenues.*
Fire & Emergency Response	*Provision of fire and emergency services, such as prevalence of firefighters, response time for emergency services.*
Health	*Provision of healthcare services and general health of the population, such as access to healthcare services, average life expectancy, infant mortality rate.*
Safety	*Law enforcement, such as crime rate, prevalence of police officers, response time from police department.*
Shelter	*Provision of housing, such as access to formal housing, registration of legal titles for households.*
Solid Waste	*Solid waste collection, such as access to solid waste collection services, recycling rate.*
Telecommunication & innovation	*Telecommunications services and connectivity, such as access to Internet and cell-phone connections.*
Transportation	*Provision of transportation services, such as rail network, car ownership, availability of bicycle lanes.*
Urban Planning	*Urban planning, such as land use planning, prevalence of green areas.*
Water & Sanitation	*Wastewater collection, water supply service and sanitation facilities such as sewer system, access to potable water, wastewater treatment.*

1 .... Please rank the **level of development** of the following sectors for your city with "1" representing the highest level of development.

[For example, if Economy has the highest level of development in your city, and Water and Sanitation has the lowest, they shall be ranked "1" and "14" respectively. Please tick the box of the respective rank of each sector.]

SECTOR	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Economy														
Education														
Environment														
Finance														
Fire & Emergency Response														
Health														
Safety														
Shelter														
Solid Waste														
Telecommunication & innovation														
Transportation														
Urban Planning														
Water & Sanitation														

2 ···· Please rank the following sectors in terms of their **relative importance to your city's overall development goals**, with "1" representing the highest level of importance.

[For example, if Economy has the highest level of importance in your city, and Water and Sanitation has the lowest, they shall be ranked "1" and "14" respectively. Please tick the box of the respective rank of each sector.]

SECTOR	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Economy														
Education														
Environment														
Finance														
Fire & Emergency Response														
Health														
Safety														
Shelter														
Solid Waste														
Telecommunication & innovation														
Transportation														
Urban Planning														
Water & Sanitation														

3 ···· Please rank the **importance of geospatial data for supporting the development** of the following sectors, relative to one another, with "1" representing the highest level of importance.

[For example, if geospatial data is most important for supporting Economy, and least important for supporting Water and sanitation, they shall be ranked "1" and "14" respectively. Please tick the box of the respective rank of each sector.]

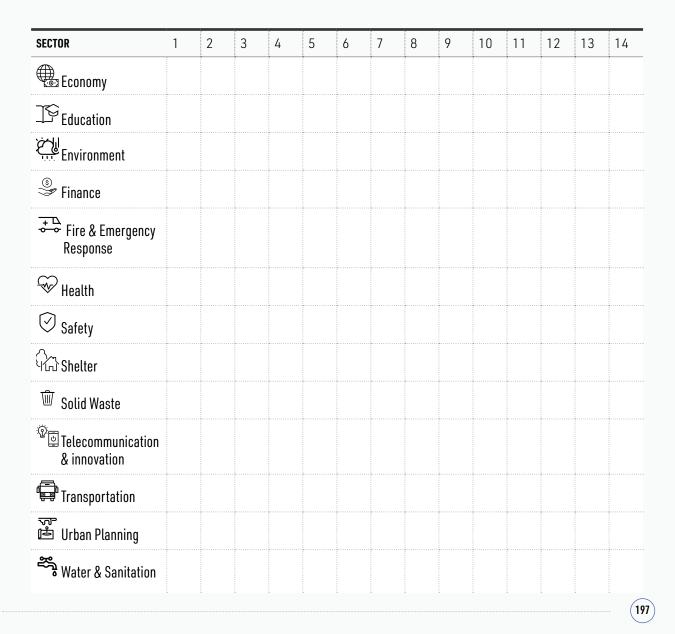| SECTOR	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Economy														
Education														
Environment														
Finance														
Fire & Emergency Response														
Health														
Safety														
Shelter														
Solid Waste														
Telecommunication & innovation														
Transportation														
Urban Planning														
Water & Sanitation														

4 How has geospatial data been used to support the development of the sectors above and your city's goals?

5 Please rank the **level of use of geospatial data in the following sectors** within your city, relative to one another, with "1" representing the highest level of use.

[For example, if Economy has the highest level of use of geospatial data in your city, and Water and Sanitation has the lowest, they shall be ranked "1" and "14" respectively. Please tick the box of the respective rank of each sector.]

SECTOR	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Economy														
Education														
Environment														
Finance														
Fire & Emergency Response														
Health														
Safety														
Shelter														
Solid Waste														
Telecommunication & innovation														
Transportation														
Urban Planning														
Water & Sanitation														

6 .... What policies and resources do you think are needed to improve the use of geospatial data in supporting the development of the sectors above in your city?

7 .... What metrics do you think would be needed to improve the monitoring of MSDI outcomes in your city?

DEEP DIVE MSDI CAPACITY ASSESSMENT

FOR KEY STAKEHOLDERS (I.E., MSDI LEAD AND CO-LEAD AGENCIES)

GENERAL QUESTIONS

1. What are the key use cases of geospatial data in your city?

2. Can you describe the development of Spatial Data Infrastructure (SDI) within your city such as the key initiatives, key city departments involved, and whether there is a strategic plan in place already?

3. What are the key drivers and challenges of MSDI implementation in your city?

4. Describe two to three use cases in your agency where the utilization of spatial data through the development of a geoportal would significantly improve the current gaps in data production and usage.

INSTITUTIONAL ARRANGEMENTS

1. Does the agency apply a usage license to the data and maps that it produces?

2. Does the agency have an open data policy? If yes, what data does it apply to?

3. Would the agency want to share data with other departments with an open license?

4. Are there currently any legal restrictions to sharing data?

5. Are there policies to ensure interoperability and implementation of standards?

6. Are there any different data access policies based on different user groups?

7. What is the interaction / linkage between the national government and the city government with respect to geospatial data?

8. Is there a written regulation on geospatial data sharing and exchange?

9. Is there a written regulation on geospatial information utilization for the public?

10. Is there a written regulation on licensing of geospatial information used by the public and private sector?

11. Is there a written regulation on access to geospatial information (classified / limited / public domain)?

12. Is there a Standard Operating Procedure (SOP) for geospatial information management?

13. What are the problems your city currently faces with respect to regulatory, policy and institutional aspects?

14. Does your city / agency have an IT strategy?

15. Is there a division/section which has special duties related to geospatial information management?

16. Does your city / agency have GIS guidelines, a strategic plan or roadmap for geospatial information management?

17. Have the activities of geospatial information management been included in future plans?

18. What is the routinely allocated budget for geospatial information management activities?

19. What is the routinely allocated budget for investments in geospatial software and applications?

20. What is the routinely allocated budget for investments and maintenance of IT infrastructure for geospatial information management?

21. Does your agency understand and commit to the development and management of geospatial information activities?

22. How could your organization better support the utilization of spatial data?

23. Does your agency cooperate with other agencies within the municipality? If so, please give the agency names and short description of the nature of cooperation for each agency (e.g. extent of data sharing etc.)

24. How can cities improve on inter-agency data sharing?

25. What are the challenges of achieving collaboration among agencies for data sharing and innovative use of geospatial data? (e.g. lack of knowledge of available data or information, access to information, files or databases)

26. What are the key investments needed/made in technological infrastructure and data?

27. Is central funding available to support these investments?

28. Has a formal cooperation protocol been established with local universities for geospatial information management activities? If yes, please provide the institution's name and a short description of the nature of the partnership.

29. Has a formal cooperation protocol with private sector organizations been established? If yes, please provide each organization's name and a short description of the nature of partnership.

PEOPLE

1. Describe the main functions of the agency.

2. How many personnel are in the agency?

3. What is the level of awareness of and support for geospatial implementation in your agency?

4. What are the data related positions in the agency?

5. How many personnel use GIS data and software in their everyday work?

6. How many personnel are able to operate and maintain the geospatial server in your agency?

7. Describe the level of GIS skills and experience possessed by your personnel in general (basic/intermediate/advanced).

8. How many permanent data / GIS specialists do you have in your department?

9. How many personnel have a formal education background in Geography / Surveying / GIS / Cartography / Urban Planning?

10. Please identify any additional skills that agency personnel have with respect to using spatial data.

11. How many personnel have a formal educational background in ICT / Computer Science?

12. Do agency personnel have experience with open source software and open data? If yes, estimate the total years of experience.

13. Do you have in-house developers? If yes, what are their skills (software, database, scripting)?

14. How many IT administrators does your department have?

15. Does the agency hire external contractors to perform internal IT or data analysis tasks? If yes, what tasks are they typically hired to do?

16. Briefly describe the general extent of spatial data utilization in your agency.

17. Are there any capacity building initiatives for data and/or GIS analysis in the agency?

18. Do you think it is important for geospatial users from different city departments to meet up at regular intervals to share best practices and their experience in dealing with geospatial data?

19. Are there universities in your city that can support geospatial initiatives within your city?

20. Are there any capacity building initiatives for data and/or GIS analysis in your agency?

21. Please identify any additional skills that agency personnel may require to aid in data management.

22. What is the average experience of personnel (in years) in the agency?

DATA

1. Give a brief description of the data that your agency possesses.

2. Give a brief description of the data that your agency produces.

3. Is there a list of Fundamental Data Sets identified in your city, and if yes, how are they identified?

4. Are there standard practices to collect and store metadata about the GIS data that your agency uses / produces?

5. Are there policies to ensure interoperability and implementation of standards?

6. What are the most common data formats used within the agency?

7. Is the agency recognized as the custodian for imagery data?

8. If your agency produces geographical data, are there quality assurance procedures in place? (if yes, please describe)

9. Who is responsible for the quality assurance of geospatial information produced in your agency?

10. Does the agency implement predefined data models and metadata schemas?

11. How does the agency ensure the security and safety of data?

12. What geodata does your department produce or maintain?

13. Are there any other imagery datasets (similar to yours) collected and maintained by other agencies in the municipality that could be considered a duplication of effort?

14. Is satellite imagery available for your city?

15. From which satellite was the imagery acquired and when (year)?

16. What data exists in other forms (tabular, paper maps, AutoCAD etc.) that could be converted to GIS data?

17. How do you store or manage the data you work with? What medium is the dataset stored on at your agency e.g., cloud, server, workstation, external hard drive, CD, DVD, paper etc.?

18. Is the data stored as a database or a file? Is the data stored in separate files (.xls, .shp, .dwg, .tab) or is it in a database (Oracle, PostgreSQL, MySQL etc.)?

19. Where is the metadata stored?

20. How do you obtain data?

21. Does the agency have experience with data collection in the field?

22. Is there a designated person who curates data and maps?

23. How do you find out what kind of GIS data is available in your municipality?

24. How do you find out what kind of GIS data is available from provincial and national governments?

25. Is the spatial information / data needed for your work easily accessible?

26. Does the agency apply a usage license to the data and maps that it produces?

27. Does the agency produce or manage sensitive data?

28. What methods are utilized to access data internally?

29. Does your agency produce GIS data that is used by other agencies? What kind of data?

30. Is data shared or published outside of the agency?

31. Does your agency use GIS data owned by other agencies? What kind of data?

32. How is data received from other departments or stakeholders?

33. How do agencies request data from each other? Do you have to login to a portal? Can you access the data through a network from a server / another workstation or do you need to approach someone to get a paper map / copy on CD / DVD?

34. Does the agency use external data / layer web services for GIS work?

35. Are there data sharing principles that guide the sharing of geospatial data among agencies and with the public (open data policy)?

36. Describe the challenges related to data / information access.

37. What data does the agency not have access to that could make its work easier or better?

38. How do you normally use the geospatial dataset? For spatial planning, master planning, transport planning etc.?

39. What datasets would benefit the agency most in order to complete its tasks?

40. What data / information that the agency produces would benefit other agencies the most?

41. Please describe the spatial analyses that your agency currently uses.

42. What are the difficulties you face with respect to using this dataset within your agency? Some examples include: lack of licenses, poor/ slow internet connection, lack of hard disk space, lack of memory, antiquated computers, etc.

43. How could the availability of information / data be improved?

44. In your opinion, how could data infrastructure in the city be improved?

45. Are there any different data access policies based on different user groups?

SYSTEMS

SOFTWARE

1. Describe the tasks where GIS data is used.

2. Please list all software programs used in the agency. Be sure to note the software program, version and current number of licenses owned by the agency.

3. Does the software currently used in the agency meet its needs? If not, describe any challenges related to software systems (lack of licenses, outdated, etc).

4. In which programs is data produced?

5. In which programs is data processed?

6. In which programs is data analysed?

7. Do the software / applications used meet your needs?

8. Does the agency have the appropriate number of licenses for all software?

9. What operating system(s) do workstations in the agency use?

10. List the geospatial servers (open source / commercial) for geospatial information management.

11. Does your agency have an official website that is frequently updated?

12. Do you use web services (e.g. WMS, WFS)?

13. Does your agency have its own web services? Is yes, please list the services.

14. Does your agency have its own GIS databases?

15. Do you have access to other agencies' GIS databases?

16. Does the agency use any open source software (i.e. Apache OpenOffice, Quantum GIS etc.)?

17. Are there any customized software/applications that are used for processes in the agency?

   o What is the application used for?

   o What are the processes and tasks that are completed using these applications?

   o How have the applications been developed?

   o What are the data sources used?

- What data do they create?

- If the application was not developed in-house, is there internal and external documentation of the application, as well as information on who developed it and how can they be contacted?

18. Does agency have any software agreements with vendors?

19. Please list the software used for spatial data collection, maintenance, and dissemination.

20. Is there someone in charge of software procurement and management for the agency?

21. How much does the agency spend on software licenses per year?

22. Are there ways to structure the datasets inputted/ generated into these applications into a 'tidy data' format?

HARDWARE

1. Please list all the workstations within the agency. This information should include the manufacturer, model, processor brand and speed, amount of memory, hard disk space, desktop or laptop, and age of each workstation.

2. Do the workstations currently used in your agency meet your needs?

3. How much does your agency typically budget for new workstations per year?

4. How often are workstations upgraded?

5. Are there any workstations that are currently under warranty? If so, when does the warranty expire?

6. Are all workstations used for similar tasks, or are certain workstations used for unique processes?

7. Who conducts maintenance/repairs on workstations (in-house IT vs. contractor)?

8. Describe the server infrastructure setup of your municipality and/or agency. If possible, please attach a network diagram.

9. Please list all servers owned by the agency, including the manufacturer, model, processor speed, amount of memory, storage space, network connection speed, and age of each server.

10. How large is the storage capacity of the servers?

11. Does the agency have enough storage capacity on its server(s)?

12. Are servers local or cloud-based?

13. If cloud-based, who provides this service?

14. Are there any regulations that determine where servers are to be housed and managed?

15. Does another entity own the server used by the agency?

16. Does your agency have access to additional government or city servers?

17. Who conducts maintenance on servers?

18. Is data backed-up? If so, how frequently and where is the back-up stored? How often is data synchronized?

19. Are there power outages at the office? How does this impact your daily tasks?

20. What hardware is available that allows for the geo-tagging of data?

21. Does your agency have access to, or own, GPS equipment?

22. Does the overall infrastructure (hardware and software) currently used in the agency meet its needs?

23. Describe any further challenges related to hardware and software systems that were not previously discussed.

NETWORK

1. Are you able to access the internet when needed? Is the connection fast enough?

2. Is the connection reliable? If not, please describe the problem (speed, reliability etc.).

3. Is the internet connection reliable enough to use web-based-services?

4. What is the available bandwidth and speed of the internet connection that you are using?

5. Who maintains the intranet/internet connections (internal IT vs. consultant/outside provider)?

6. What network security measures are in place? Do they prevent users from performing certain tasks?

GEOPORTAL

1. Does a consolidated platform for finding geospatial data and services exist?

   If yes, continue question below. If no, please jump to question no. 11

2. Does the platform provide the following functionality?

   ○ Sorting and cataloguing of datasets following the data's associated information? (e.g: data theme, data custodian, names, etc)

   ○ Uploading and downloading of geospatial datasets?

   ○ Webmap visualizations?

3. Is the portal accessible to the public?

4. Are there any other methods for the public to access information that is stored in this portal? Please describe briefly.

5. Is there a means for other applications/ portals to connect to this portal? Please describe briefly.

6. Are there different levels of access to information in the portal, based on the nature of datasets?

7. Are there different levels of access to information in the portal, based on the types of users? (i.e: public, government officials, admins etc.)

8. Is there a process in place to ensure that data information is uploaded to this portal? Please describe briefly.

9. Is there a process in place to verify datasets before it is uploaded in the portal? Please describe briefly.

10. What is the approximate monthly user traffic for this portal?

If no

11. Do you think a geoportal can facilitate collaboration among agencies? What needs to be in place to achieve this?

12. Which GIS data sets would you like to add to a geoportal first? Why?

13. Which agency would benefit the most if they start using a geoportal?

14. How do you think a geoportal can provide geospatial information to the public? What tools and functions are needed?

15. How can we integrate crowd-source data from the public or private sector data? How can we control data quality?

FOR OTHER AGENCIES

INSTITUTIONAL ARRANGEMENTS

1. Does the agency apply a usage license to the data and maps that it produces?

2. Does the agency have an open data policy? If yes, what data does it apply to?

3. Would the agency want to share data with other departments with an open license?

4. Are there any legal restrictions to sharing data?

5. Does the agency produce or manage sensitive data?

6. Are there policies to ensure interoperability and implementation of standards?

7. Are there any different data access policies based on different user groups?

8. Does your municipality / agency have an IT strategy?

9. Is there a Division/Section which has special duties related to geospatial information management?

10. Does your municipality / agency have GIS guidelines, strategic plan or roadmap for geospatial information management?

11. Have the activities of geospatial information management been included in future plans?

12. What is the routinely allocated budget for geospatial information management activities?

13. What is the routinely allocated budget for investments in geospatial software and applications?

14. What is the routinely allocated budget for investments and maintenance of IT infrastructure for geospatial information management?

15. Does your agency understand and commit to the development and management of geospatial information activities?

16. How could your organization better support the utilization of spatial data?

17. Does your agency cooperate with other agencies within the municipality? If so, please give the agency names and short description of the nature of cooperation for each agency (e.g., extent of data sharing etc.)

18. How can cities improve on inter-department data sharing?

19. What are the challenges of achieving collaboration among agencies for data sharing and innovating use of geospatial data? (e.g. lack of knowledge of available data or information, access to information, files or databases.)

20. What are the key investments needed/made in technological infrastructure and data?

PEOPLE

1. How many personnel are in your agency?

2. What are the data / analysis related positions in the agency?

3. How many personnel have an educational background in ICT / Computer Science/ Geography / Surveying / GIS / Cartography/ Urban Planning?

4. How many permanent data and/or GIS specialists do you have in your department?

5. Does the agency hire external contractors to perform internal IT or data analysis tasks? If so, what tasks are they typically hired to do?

6. Within the agency, are there the right number of personnel with the appropriate skills to manage the agency's data? (Y/N)

    If yes, please list their positions, years of experience and pertinent skills (data collection, data maintenance, CAD skills, GIS skills, etc.)

    If no, would your organization be supportive of expanding your capacity/capability?

DATA

1. Are there standard practices to collect and store metadata about the GIS data that your agency uses / produces?

2. What are the most common data formats used within the agency?

3. Is the agency recognized as the custodian for imagery data?

4. What geodata does your department produce or maintain?

5. How do you store or manage data you work with? What medium is the dataset stored on at your agency e.g., cloud, server, workstation, external hard drive, CD, DVD, paper etc.?

6. Is the data stored as a database or a file? Is the data stored in separate files (.xls, .shp, .dwg, .tab) or is it in a database (Oracle, PostgreSQL, MySQL etc.)?

7. Where is the metadata stored?

8. Does your agency produce GIS data that is used by other agencies? What kind of data?

9. Is data shared or published outside of the agency? How is it accessed by external agencies?

10. Does your agency use GIS data owned by other agencies? What kind of data?

11. How is data received from other departments or stakeholders?

SYSTEMS
SOFTWARE

1. Please list all software programs used in the agency. Be sure to note the software program, version, and current number of licenses owned by the agency.

2. Does the software currently used in the agency meet its needs? If not, describe any challenges related to software and systems (lack of licenses, outdated version, crashed often, etc)

3. Describe the tasks where GIS data is used.

4. In which programs is data produced?

5. In which programs is data processed?

6. In which program is data analysed?

7. Do the software / applications used meet your needs?

8. Does the agency have the appropriate number of licenses for all software?

9. What operating system(s) do workstations in the agency use?

10. Are there any customized software/applications that are used for processes in the agency?

11. Does the agency use any open source software (i.e. Apache OpenOffice, Quantum GIS etc.)?

HARDWARE

1. Please list all the workstations within the agency. This information should include the manufacturer, model, processor brand and speed, amount of memory, hard disk space, desktop or laptop, and age of each workstation

2. Are there any workstations that are currently under warranty? If so, when does the warranty expire?

3. How much does the agency typically budget for new workstations per year?

4. How often are workstations upgraded?

5. Are all workstations used for similar tasks, or are certain workstations used for uniqe processes?

6. Who conducts maintenance/repairs on workstations (in-house IT vs. contractor)?

7. Please list all servers owned by the agency, including the manufacturer, model, processor speed, amount of memory, storage space, network connection speed, and age of each server.

8. Describe the server infrastructure setup of the agency. If possible, please attach a network diagram.

9. Does the agency have enough storage capacity on its server(s)?

10. Does the agency have access to additional government or city servers?

11. Are agency servers local or cloud-based?

12. If cloud-based, who provides this service?

13. Are there any regulations that determine where servers are to be housed and managed?

14. Who conducts maintenance on servers (in-house IT vs. contractor)?

15. Is data backed-up? If so, where is the back-up stored and how often is data synchronized?

NETWORK

1. What is the available bandwidth and speed for the internet connection?

2. Are users able to access the internet on demand? If not, please describe why.

3. Is the connection fast and reliable enough for typical tasks?

4. Is the internet connection reliable enough to use web-based services?

5. Who maintains the agency's intranet/internet connections?

6. What network security measures are in place and do they prevent users from performing certain tasks?

DATA INVENTORY

This assessment aims to provide an exhaustive overview of the current state of spatial data (type, availability, format, ownership etc) in the city. This is a useful document for the city to have in order to understand the status of its data inventory. Specifically, it will form the basis of inputs to the geoportal.

NO.	NAME OF DATA	FILE NAME	DESCRIPTION	OWNER	PRODUCER	USERS	LANGUAGE	SPATIAL COVERAGE % OF MUNICIPALITY'S TOTAL AREA	DATE OF DATA CREATION	UPDATING INTERVAL	DATE OF LAST UPDATE	RASTER / VECTOR/ TABULAR	COORDINATE SYSTEM	SCALE
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

OPEN DATA (YES/NO)	POSSIBLE LEGAL RESTRIC-TIONS	METADATA EXISTS (YES/NO)	STORAGE PLACE (NETWORK PATH)	STORAGE MEDIA (CLOUD, SERVER, WORK-STATION, EXTERNAL HARD DRIVE, CD, DVD, PAPER)	STORAGE FORMAT FOR DIGITAL PRODUCTS (DATABASE/ FILE)	DATABASE TYPE	FILE FORMAT (.SHP / .TAB / .DGN / .DWG / ETC.)	IN WHICH PROGRAM WAS THE DATA PRODUCED	IN WHICH PROGRAM IS THE DATA USED?	THREE MOST IMPORTANT DATA SETS FOR YOUR AGENCY (MARK WITH X)	HOW DO YOU GET ACCESS TO DATA?	FOR WHAT PURPOSE YOU NEED THE DATA?	LIST BRIEFLY POSSIBLE DIFFI-CULTIES REGARDING DATA USAGE
16	17	18	19	20	21	22	23	24	25	26	27	28	29

The geospatial data itself describes the physical location of geographic features, and their relationship with other features. Spatial information can be presented in many forms, including maps, remotely sensed imagery, and aerial photographs. However, any tabular data which contains its spatial information and/or coordinates, and therefore can be mapped, may also be considered spatial.

NO.	QUESTIONS	DESCRIPTION
1	No.	Number #
2	Name of data	What is the common name of the dataset in the local language? (for example, 'hospital locations')
3	File name	What is the file name? For example: hospital_locations.shp
4	Description	Give a brief description of what the dataset contains. For example: the location point taken at the front entrance of hospitals in Kota Semarang (1997-2007)
5	Owner	What is the department, city, person, or other entity that owns the right to this dataset?
6	Producer	Who created the dataset? What agency, person, or other entity made the data? Have consultants created the data? If consultants were used for dataset development, then please give the consultant's information
7	Users	Who are the intended users of the data set? Who has permission to access it?
8	Languages	Are there any legal restrictions to the sharing of this data? If there are restrictions on who can see or use the data, then please briefly describe those restrictions.
9	Spatial coverage % of municipality's total area	Is this data recorded for the whole city, or is it only available in a sub-city level such as a ward, or other form of sub-district? If the data set is not city-wide, please specify the sub-district or the approximate % of the city area the dataset covers

NO.	QUESTIONS	DESCRIPTION
10	Date of data creation	When was this data first created?
11	Updating interval	How often is the data supposed to be updated? For example: annually, monthly, daily etc.
12	Date of last update	What is the date the dataset was last updated?
13	Raster/ vector/ tabular	Vector/ raster/ tabular
14	Coordinate system	What is the coordinate system used for the location data? (WGS 1984 etc.) if available, what is the EPSG code? (from the EPSG Geodetic parameter dataset) if the map is on paper, what is the map projection used?
15	Scale	What is the scale of the data/ map?
16	Open Data (yes/ no)	Is the data free of legal restrictions as to who can view it and is it free for use? Is there a fee or is special permission needed to access this data? If the data is free of legal restrictions, and is it free for use, then it is considered 'open data', mark it as 'yes'
17	Possible legal restrictions	Are there legal restrictions on the use and distribution of this data? If there are legal restrictions on the use of or access to this data, briefly describe them
18	Metadata exists (yes/ no)	Metadata is "structured information that describes, explains, locates, or otherwise makes it easier to retrieve, use or manage an information resource". Examples of metadata are title, author, subject, keywords, notes on collection method, version number, date developed
19	Storage place (network path)	Where is the dataset stored? Please give the file path for the dataset.

NO.	QUESTIONS	DESCRIPTION
20	Storage media (cloud, server, workstation, external hard drive, CD, DVD, paper)	What medium is the dataset stored on e.g., cloud, server, workstation, external hard drive, CD, DVD, paper etc.?
21	Storage format for digital products (database/ file)	Is the data stored as a database or a file? Is the data stored in separate files (.xls, .shp, .dwg, .tab) or is it in a database (Oracle, PostgreSQL, MySQL etc.)? If the answer is database, then complete Column 22-'Database Type'. If the answer is file, then complete column 23-'File format'
22	Database type	What type of database is used for storage? (SQL server, oracle, post-gis, etc.) If Oracle, is it Oracle Spatial or regular Oracle? Is attribute data and geometry data in the same place or are they stored separately?
23	File format (.shp/ .tab/ .dgn/ .dwg/ etc)	What format is the file in?
24	In which program was the data produced?	Please note all programs (including the version) that were used to develop this dataset. Was it developed using more than one program? For example, if the dataset was in a .csv file in Excel 2013, and imported into ArcGIS 10.1, the both Excel 2013 and ArcGIS 10.1 should be noted

NO.	QUESTIONS	DESCRIPTION
25	In which program is the data used?	What program(s) is the data meant to be used in? Which program(s) do you currently use it in?
26	Three most important data sets for your agency (mark with an x)	Describe the key datasets you use on a frequent basis.
27	How do you get access to the data?	Do you have to login to a portal? Can you access the data through a network from a server/ another workstation, or do you need to approach someone to get a paper map/ copy on CD/ DVD? For example: Freddie is using ArcView, can he simply add data from the computer, or does he log-in to a network server, or does he have to go to someone else and ask for CD, DVD, or paper version and then revise it?
28	For what purpose do you need the data?	How do you normally use the dataset? For spatial planning, master planning, transport planning etc?
29	List briefly the possible difficulties related to data usage	Some examples include: lack of licenses, poor/ slow internet connection, lack of hard disk space, lack of memory, antiquated computers, etc.

FUNDAMENTAL DATA SET (FDS) ASSESSMENT

The FDS Assessment analyzes the level of FDS availability in cities, using the FDS keyword matrix and the consolidated Data Inventory survey as its main inputs. Teams should modify the FDS keyword matrix, following the FDS list that has been identified as appropriate for the city which this assessment is conducted for. A simple string-matching algorithm written in the R programming language is used for this exercise, to ensure that the assessment can be done in a consistent, replicable manner, using the keywords that are identified in the FDS keyword matrix.

The algorithm takes in an FDS keyword matrix, formatted in the following manner:

Data Themes	Datasets	Keyword1	Keyword2	Keyword3	Keyword4	Keyword5
Geodetic control network/ spatial references	Geodetic control points	Geodetic				
Geodetic control network/ spatial references	Height dataum	Height	Datum			
Geodetic control network/ spatial references	Geoid model	Geoid				
Regional boundaries	Administrative boundaries	…				
…	…	…	…	…	…	…

FIGURE 23

FDS keyword matrix from the Indonesian example (containing 14 data themes, and 49 datasets in total – teams should modify this matrix following the relevant data themes and datasets included in the context's FDS list)

The algorithm performs a string matching operation using the keywords within the Keyword1 to Keyword5 columns, to first filter out non-FDS data from the Data Inventory table, as well as select and join the identified FDS datasets to a new table, sorted by their data themes. These are complemented by two plots that represent:

- Overall percentage of FDS that cities have, out of the entire FDS list, and

- Percentage of FDS that cities have, sorted according to the FDS category

The plots provide cities with a quick way to assess their FDS availability. It does not however, evaluate the quality of these datasets. This information could then be further used to initiate a discussion on which FDS to procure next, or which existing FDS the city should improve.

Full documentation of the assessment is available as a separate document (.pdf/ .doc/ .html/ .Rmd) upon request. We recommend requesting the documentation in its R markdown (.Rmd) version, to allow users to immediately replicate the analysis by executing the codes in the markdown file from within the R-Studio environment.

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FIGURE 24

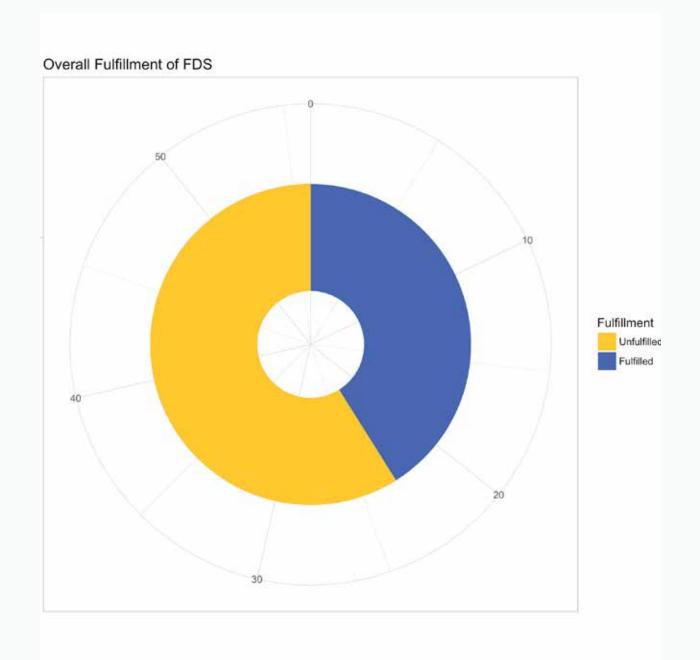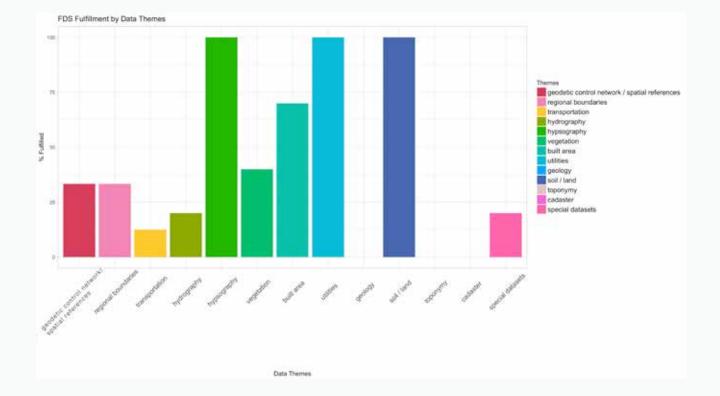*Indonesian City of Balikpapan overall FDS fulfillment: 38.98% (23 out of 59 FDS available)*

Overall Fulfillment of FDS

Fulfillment
- Unfulfilled
- Fulfilled

FIGURE 25

Indonesian City of Balikpapan FDS fulfillment by FDS categories (14 categories, with 59 datasets in total)

FDS Fulfillment by Data Themes

BIBLIOGRAPHY

Abdulharis, R., van Loenine, B., Zevenbergen, J. 2005. Legal Aspects of Access to Geo-Information Within Indonesian Spatial Data Infrastructure. pg:147-154.International Society for Photogrammatry and Remote Sensing Workshop on Service and Application of Spatial Data Infrastructure, XXXVI (4/W6), Oct.14-16, Hangzhou, China. Source: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.104.2520&rep=rep1&type=pdf Retrieved: January 25, 2019

Australia New Zealand Land Information Council. 2014. The Australian and New Zealand Foundation Spatial Data Framework: Making Common Foundation Spatial Data Ubiquitous Across Australia and New Zealand. Source: http://anzlic.gov.au/sites/default/files/files/One_ANZ_Foundation_Spatial_Data_Framework_Booklet.pdf

Bertino, E., Thuraisingham, B., Gertz, M., Damiani, M. 2008. Security and Privacy for Geospatial Data: Concepts and Research Direction. DOI: 10.1145/1503402.1503406. Source: https://www.researchgate.net/publication/48205475_Security_and_privacy_for_geospatial_data_Concepts_and_research_directions Retrieved: January 25, 2019

Box, P., Simons, B., Cox, S., & Maguire, S. 2015. A Data Specification Framework for the Foundation Spatial Data Framework. CSIRO. Source: https://www.anzlic.gov.au/sites/prod.auzlic/files/files/FSDF-Data_Specification_Framework.pdf Retrieved: January 15, 2018

Canada Centre for Mapping and Earth Observation, Natural Resources. 2007. Canadian Geomatics Accord, 2007-2013. Source: https://www.nrcan.gc.ca/evaluation/reports/2018/21250. Retrieved: February 18, 2019

Canadian GIS & Geomatics (2013), The Value of Geospatial Information in Economy. Source: https://canadiangis.com/value-geospatial-information-economy.php retrieved: October 15, 2018.

Craglia, M. 2015. Spatial Data Infrastructures. International Encyclopedia of the Social & Behavioral Sciences 22(2nd):130-135. Elsevier Ltd. DOI: 10.1016/B978-0-08-097086-8.72058-7

Coetzee, S., Cooper, A., Rautenbach, V. 2014. Guidelines of Best Practice for the Acquisition, Storage, Maintenance and Dissemination of Fundamental Geo-Spatial Datasets. Source: http://sdistandards.icaci.org/wp-content/uploads/2014/10/MAfA_SectionC_Integrated_V10.pdf Retrieved: January 20, 2019

Dasgupta, A. .n.d. Spatial Data Infrastructure: So close, yet so far? Source: https://www.geospatialworld.net/article/spatial-data-infrastructure-so-close-yet-so-far/. Retrieved: February 26, 2019

Docan, D. 2013. Spatial Data Quality Assessment in GIS. Technical University of Civil Engineering Bucharest. pg:105-112. ISBN: 978-960-474-335-3. Source: https://pdfs.semanticscholar.org/3803/356807cc1555c2d239434cc4e7e04be1fc7b.pdf. Retrieved: January 10, 2019

ESRI. 2002. Metadata and GIS. ESRI. Source: https://www.esri.com/library/whitepapers/pdfs/metadata-and-gis.pdf. Retrieved: January 25, 2019

Gaudet, C, Annulis, H, Carr, Jon. 2001. Workforce Development Models for Geospatial Technology. The University of Southern Mississippi. Source: https://www.careeronestop.org/competencymodel/modelfiles/000_wfd_models_final_report_10_23_2001.pdf. Retrieved: January 22, 2018

Global Spatial Data Infrastructure. 2012. SDI Cookbook. GSDI. Source: http://gsdiassociation.org/images/publications/cookbooks/SDI_Cookbook_GSDI_2004_ver2.pdf Retrieved: January 15, 2018

Ikäheimo, A. and Milla L. 2017. MSDI Assessment and Roadmap: City of Semarang

Ionita, A, Visan, M. 2006. Research Institute for Artificial Intelligence, Romanian Academy Intergraph Computer Services. Source: An integrated platform for learning, training, innovation and discovery. http://inspire.ec.europa.eu/events/conferences/inspire_2014/pdfs/20.06_1_09.00_Angela_Ionita.pdf Retrieved: March 14, 2019

Koseki, J. 2002. Standardization of Geographic Information. International Cooperation in the Field of Infrastructure Development. Pg: 119-120. Source: http://www.mlit.go.jp/sogoseisaku/inter_e/project/technology/pdf/geographic_sys_e.pdf Retrieved: January 5, 2019

Maguire, D, Longley, P. 2004. The Emergence of Geoportals and Their Role in Spatial Data Infrastructures. Computers, Environment and Urban Systems 29():3-14. DOI: 10.1016/j.compenvurbsys.2004.05.012

MEASURE Evaluation. 2017. Tidy Data: The Key to Success with Spatial Data. MEASURE Evaluation. Source: https://www.measureevaluation.org/resources/publications/sr-17-142/at_download/document Retrieved: January 7, 2019

National Academy of Sciences. 2012. Advancing Strategic Science: A Spatial Data Infrastructure Roadmap for the U.S. Geological Survey. The National Academies Press. ISBN: 978-0-309-26457-0. DOI: 10.17226/13506. Source: https://www.nap.edu/download/13506 Retrieved: May 21, 2018

National Academy of Sciences. 2013. Future US Workforce for Geospatial Intelligence. The National Academies Press. ISBN: 978-0-309-38772-9. DOI: 10.17226/18265. Source: https://www.nap.edu/download/18265 Retrieved: May 20, 2018

National Institute of Statistics and Geography. 2017. Mexico's National Geostatistical Framework, and Geospatial Tools for the 2020 Population and Housing Census. Source: http://ggim.un.org/ggim_20171012/docs/meetings/GGIM7/3%20-%20Rolando%20Ocampo%20Alcántar.pdf

Open Knowledge International. Machine Readable. Open Knowledge International. Source: http://opendatahandbook.org/glossary/en/terms/machine-readable/ retrieved: January 7, 2019

PAIGH. 2017. Fundamental Geospatial Data. Pan American Institute for History and Geography. Source: https://www.ipgh.org/assets/fgd.pdf Retrieved: January 11, 2018

Setiawan, I., Sutanta, H., Rachmat, S. Y., and Gularso, S.K. 2016. Geospatial Technical Support Final Report.

Singapore Land Authority. 2018. Deep Dive Assessment and Municipal Spatial Data Infrastructure Road Map Development. The World Bank: City Planning Labs.

The National Geospatial Digital Archive. 2017. NGDA Lifecycle Maturity Assessment Dashboard. The National Geospatial Digital Archive. Source: https://dashboard.geoplatform.gov/lma?assessments=2017 Retrieved: January 25, 2019

The World Bank – City Planning Labs team. 2018. Balikpapan Assessment for MSDI Roadmap Development.

United States Department of Labor. 2014. Geospatial Technology Competency Model. United States Department of Labor. Source: https://www.careeronestop.org/CompetencyModel/competency-models/pyramid-download. aspx?industry=geospatial-technology. Retrieved: January 21, 2018

United Nations Economic and Social Council. 2013. Spatial Data Infrastructure (SDI) Manual for the Americas. United Nations Economic and Social Council. Source: https://unstats.un.org/unsd/geoinfo/rcc/docs/rcca10/E_Conf_103_14_ PCIDEA_SDI%20Manual_ING_Final.pdf. Retrieved: March 11, 2019

United Nations Expert Group on the Integration of Statistical and Geospatial Information. 2016. Proposal for a Global Statistical Geospatial Framework. United Nations Expert Group on the Integration of Statistical and Geospatial Information. Source: http://ggim.un.org/meetings/GGIM-committee/documents/GGIM6/Background-Paper-Proposal-for-a-global-statistical-geospatial-framework.pdf Retrieved: January 24, 2019

United Nations Economic Commission for Africa. 2007. Determination of Fundamental Datasets for Africa. Source: https://www.uneca.org/sites/default/files/PublicationFiles/geoinformation_socio_economic_dev-en.pdf Retrieved: January 9, 2018

United Nations Committee of Experts on Global Geospatial Information Management. 2018. A Guide to the Role of Standards in Geospatial Information Management. UN-GGIM. Source: http://ggim.un.org/meetings/GGIM-committee/8th-Session/documents/Standards_Guide_2018.pdf Retrieved: November 29, 2018

United Nations Committee of Experts on Global Geospatial Information Management. 2016. Core Data Scope. UN-GGIM. Source: http://un-ggim-europe.org/sites/default/files/UN-GGIM-Europe%20WGA%20Core_Data_Scope-v1.2.pdf Retrieved: January 10, 2018

SYSTEMS ——————————————— —

DATA

PEOPLE ——————————————— —

INSTIT