DOST Framework for Smart Sustainable Communities and Cities

Department of Science and Technology
DOST Regional Offices
Philippine Council for Industry, Energy and Emerging Technology
Research and Development

SGV
Building a better
working world

FOREWORD

Philippine smart cities are set to move forward in a more innovative and collaborative manner as the Department of Science and Technology – Philippine Council for Industry, Energy and Emerging Technology Research and Development (DOSTPCIEERD) launches its latest formulation of a framework for smart sustainable communities and cities.

This framework serves as guide in conceptualizing and prioritizing research aimed at developing active, vibrant and sustainable cities by leveraging smart city solutions. It highlights the importance of building data infrastructure and integrating them in management decision support tools for cities in order to spur innovations and to help solve complex urban problems. Smart city solutions are also thought to identify opportunities for citizens to pursue prosperity and fulfillment especially in emerging and rapidly growing regions.

These ready-worthy contents were thought out to support the innovation policies and strategies of cities aspiring to become smart or even smarter than they may already be now. It can also be a useful tool among decision makers to check the viability of technology-oriented projects or interventions being introduced in their communities to meet the growing demands and evolving challenges faced by their citizens.

Being at the forefront of innovation and transformation, DOST-PCIEERD commits to finding new and better ways to serve the Filipino community and lend its support to generate more technologically enhanced products and science-based solutions. It will constantly support R&D endeavors that will truly shape, mold, and accelerate the future of the Philippine economy and society, explore new frontiers and make innovation work for the people.

DR. ENRICO C. PARINGIT
PCIEERD Executive Director

Table of
Contents

By 2050 the world population is expected to reach nearly 10 billion people[1].

80%

Amount of people living in cities in 2050[2]

2%

Surface occupied by today's cities on the earth's surface

60%

Amount of energy consumed by actual cities

70%

Amount of waste and greenhouse gas emissions produced by cities[3]

1) United Nations Sustainable Development Goals, press release, June 2017
2) World Food Research and Innovation Forum
3) Habitat III: The United Nations Conference on Housing and Sustainable Urban Development

DOST Framework for Smart Sustainable Communities and Cities

Source: worldgbc.org

The Department of Science and Technology aims to address challenges of urban and regional life in cities through the use of science, technology and innovation to enhance opportunities and address challenges relating to sustainable urban development and smarter cities as illustrated in Figure 1. The DOST Smarter City Framework aims to enhance research collaboration and to fund excellent research with lasting impact.

The specific objective is to fully exploit the potential of the regions talent pool and maximize the benefits of an innovationled economy with the following perspectives:

- Integration of different dimensions of urban sustainability in the framework of the UN Sustainable Development Goals.
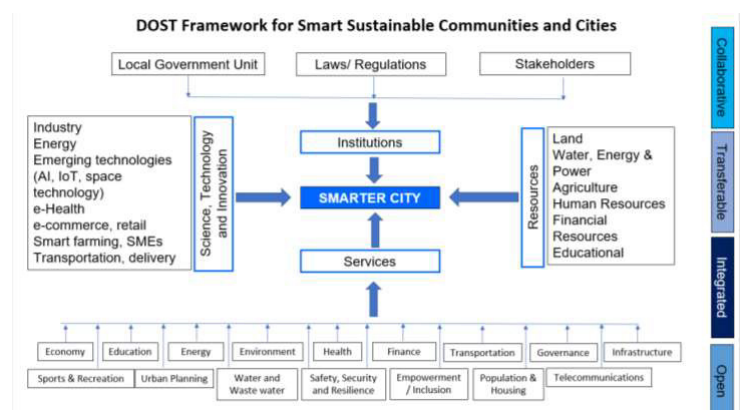- Co-production – a way to extend research activities to bridg gaps between knowledge, understanding, and action.

Figure 1. DOST Framework for Smart Sustainable Communities and Cities

Definition of Terms

Smart City

-is an ecosystem comprised of people, organizations and businesses, policies, laws and processes integrated together to create desired outcomes as illustrated in Figure 1. The city is adaptive, responsive, relevant, and integrates technology to accelerate, facilitate, and transform this ecosystem.

Smart City as an ecosystem

-that offers a variety of services to the people, ensure information exchange between subsystems, and enables analysis of information, creation of statistics for optimizing resource utilization.

Sustainable Smart City

-that offers a variety of services to the people, ensure information exchange between subsystems, and enables analysis of information, creation of statistics for optimizing resource utilization.

What is a smarter city approach of DOST?

A smart cities approach aims to achieve meaningful outcomes for the communities or stakeholders by leveraging the fundamental benefits that data and connected technology have to offer:

• Collaboration

Convergence of existing technologies and services developed enables communities to bring traditional and non-traditional partners together to collaborate.

• Transferability

When tools and technological approaches are opensource, transparent, and standardized, they can be used by communities across the country, no matter their size or capacity.

• Integration

Data and connected technology empower communities to break down silos that exist within local governments and public organizations. An inventory of the current technologies developed by DOST and available technologies being used by the Local Government Unit combined with socioeconomic analysis can help identify the priority sectors as illustrated in Figure 2. These priority identification processes aim to harness co-creation and development of collective initiatives to spur ecosystems of smart solutions for sustainable communities and cities.

• Openness

When communities make their data truly accessible, transparent, usable, and secured, their decisionmaking processes become transparent, empowering citizens and strengthening the relationship between residents and public organizations. Making our data transparent and accessible would allow its utilization for planning, designing, and transforming services. Data is the new "oil" which drive smart cities today. Thus, there is also a need to protect it from cyberattacks.
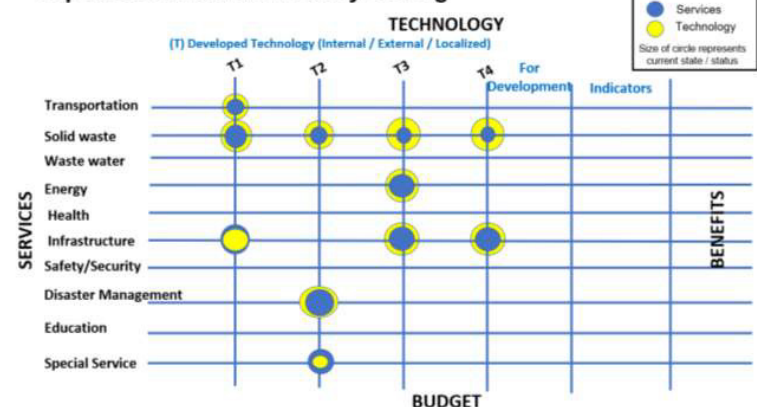
• Shared Vision / Human Centric

Figure 2. Sample Gap Assessment and Priority Setting Framework

3

Turning city vision to reality

ISO 37106 helps cities deliver their vision for a sustainable future and define a smart operating model for cities, which enables them to operationalize their vision, strategy and policies at a faster pace with greater agility and with lower delivery risk. It serves as a toolkit of smart practices for managing governance, services, data and systems across the city in an open, collaborative, citizen-centric and digitally-enabled way. It also provides practical support to help cities and communities when:

- Operationalizing the vision, strategy, and policy agenda they have developed following the adoption of ISO 37101, the management system for sustainable development of communities;

- Embedding the set of ISO 3712x city indicators into the governance processes of the city; and

- Understanding how and when to deploy ISO3715x standards on smart community infrastructure. ISO 37106 global interoperability is illustrated in Figure 3.
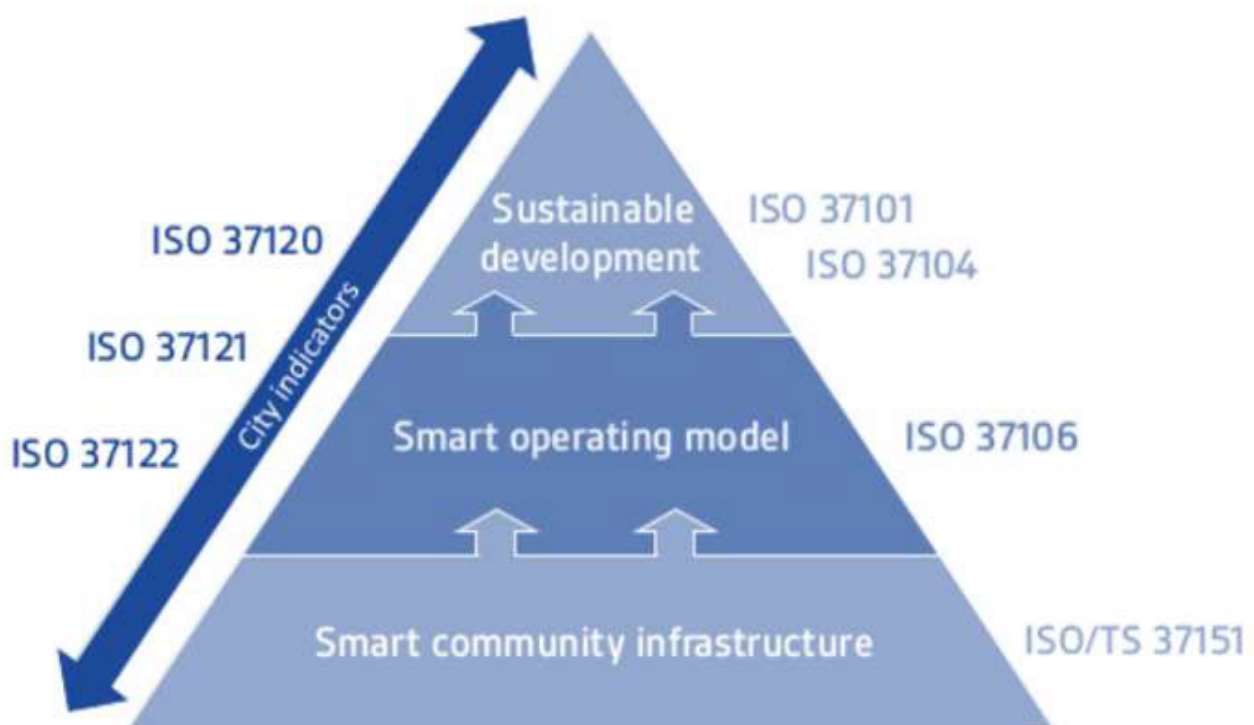

Figure 2. Sample Gap Assessment and Priority Setting Framework

Smart City Indicators

The smarter city indicators towards sustainable development of communities include the following themes:

Economic Opportunity

Residents are supported by a thriving local economy. Examples of outcomes in this area could include increased employment opportunities, reductions in processing times for business permits, and improvements in skill levels in the local labor force. It could also include ICT solutions or services to support innovation and technological development of MSMEs; and promotion of startups related to ICT on health, biomedical devices, among others.

Core indicators

- City's unemployment rate
- Assessed value of commercial and industrial properties as % of total assessed value of all properties
- Percentage of city population living in poverty. Use of FIES (Family Income and Expenditure Survey)
- Percentage of the city labor force working in the tourism sector
- Percentage of small and mediumsized enterprises (SMEs)
- Bounce back capacity (economic recovery rate / index)

Supporting Indicators

- Percentage of persons in full time employment
- Youth employment rate
- Number of businesses per 100,000 population
- Number of new patents per 100,000 populations per year
- Number of available support programs (financial/capacity building for farmers / MSMEs
- Number of farmers / MSMEs using or into online platforms

Education

A key ingredient in smart city development focusing on basic educati a key ingredient in smart city development focusing on basic education, advanced training and certification in universities and community colleges, e-learning infrastructure, lifelong learning, adult education, and innovation in education technologies, among others. There is also a need to include development of human resource on ICT, Internet of Things (IoT), big data, Artificial Intelligence (AI), and cybersecurity to support the framework. on, advanced training and certification in universities and community colleges, e-learning infrastructure, lifelong learning, adult education, and innovation in education technologies, among others. There is also a need to include development of human resource on ICT, Internet of Things (IoT), big data, Artificial Intelligence (AI), and cybersecurity to support the framework.

Core indicators

- Most children have access to a good school
- Lifelong learning opportunities are provided by local institutions
- Primary and secondary education student-teacher ratio
- Percentage of students with classroom access to ICT facilities
- Percentage of students with reliable access to internet

Supporting Indicators

- Number of higher education degrees per 100,000 population
- Percentage school-aged population enrolled in schools
- Percentage of students completing primary education. Use of key indicators by DepEd.Schools / teachers usually adapt a culture of "pass-all", "no one left behind"
- Percentage of students completing secondary education
- Number of schools offering higher education
- Number of schools capable of offering online education

Environmental Quality

Residents are able to enjoy a healthy environment. Examples of outcomes in this area could include: reduced greenhouse gas emissions; reductions in environmental contaminant levels; habitat preservation or renewal, and good solid waste management.

Core indicators

- Air pollution is not a problem
- Air quality index (AQI) based on reported value for: Particulate matter (PM2.5, PM 10)
- Air quality index (AQI) based on reported value for: NO2 (nitrogen dioxide), SO2 (sulphur dioxide), O3 (ozone)
- Greenhouse gas (GHG) emissions per capita
- A website or App allows effective monitoring of air pollution
- Percentage of households covered by an audited Water Safety Plan

- Percentage of solid waste - disposed to sanitary landfills
- Percentage of solid waste - burnt in an open area
- Percentage of solid waste - incinerated
- Percentage of solid waste - disposed to an open dump;
- Percentage of solid waste - recycled
- Percentage of solid waste - total amount of solid waste produced

Water and Wastewater

With 40% of the world's population living in water-stressed areas or exposed to polluted water sources, managing the current and planning for future needs of communities is another pain point for cities. Water availability, management of waterborne diseases and contaminated water will be considered.

Core indicators

- Water consumption per capita
- Percentage of households with access to a basic water supply
- Percentage of households with a safely managed drinking water service
- Percentage of water loss in the water distribution system
- Freshwater consumption
- Percentage of wastewater receiving treatment (Primary, secondary and tertiary)
- Percentage of households covered by an audited Water Safety Plan
- Percentage of households served by wastewater collection
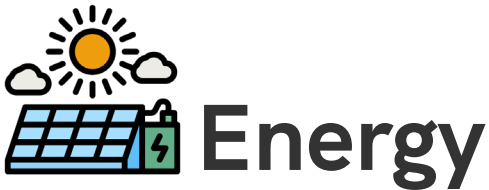
Energy

Meeting the energy needs of growing populations in a sustainable manner is a key pain point for cities. Methods for calculating energy savings, taking into consideration end-use sectors such as households, industry, services, agriculture and transport are needed. Renewable source of energy will be a priority to sustain smart cities.

Core indicators

- Total residential electrical energy use per capita
- Percentage of city population with authorized electrical service
- Energy consumption of public buildings per year
- Percentage of total energy derived from renewable sources as a share of the city's total energy consumption

Supporting Indicators

- Electricity consumption per capita
- Average number of electrical interruptions per customer per year
- Average length of electrical interruptions
- Recycling and tracking energy usage via apps, as example
- Reduced downtimes and related costs

Finance

Private and public sectors identified as to who will be putting investments in these areas for development, will contribute to local gross domestic product. This phase recognizes the fact that the Philippine national government has limited budget to accommodate ambitious projects such as this one, so the commitment coming from the local governments to a fiscal responsibility is crucial in the achievement of the city's goals and objectives.

Core indicators

- Debt service ratio (debt service expenditure as a percentage of a municipality's own source of revenue) reduced corruption.

Supporting Indicators

- Capital spending as a source of total expenditures
- Own-source revenue as a percentage of total revenues
- Tax collected as a percentage of tax billed

Governance

Ability to leverage on the collection, processing, and use of data to make more effective and efficient everyday decisions for smarter governance. The establishment of a data hub is important to ensure an evidence-based planning and decision-making approach for the city executives, as they are guided by a facility that can monitor the impacts, externalities, and progress of the city under its projects. Through the data hub, data is basically devolved and localized to the city governments for use in support & guidance of their local planning and decisions. Broadening our perspectives, the concept of a smart city really revolves around making better and more informed decisions through careful assessment and use of data.

Core indicators

- Information on local government decisions are easily accessible.
- Online public access to city finances has reduced corruption.
- Corruption of city officials is not an issue of concern.
- Online voting has increased participation.
- Residents contribute to decision making of local government.
- An online platform where residents can propose ideas has improved city life.
- Residents provide feedback on local government projects.

Supporting Indicators

- Percentage of women employed in the city government workforce
- Citizen's representation; no. of local officials elected to office per 100,000 population
- No. of registered voters as a % of the voting age population
- Voter turnout in the municipal election (as % of eligible voters)
- Women as a % of total elected to city-level office

Health and Living Recreation

Residents are able to live an active and healthy life. Examples of outcomes in this area could include: increased access to recreational programming; availability of remote health services; reduction in adverse health outcomes, and sanitation, and better or easier access to patient's profile.

Core indicators

- Medical services provision is satisfactory
- Arranging medical appointments online has improved access.
- Average life expectancy
- Online reporting of city maintenance problems provides a speedy solution.
- Number of nursing and midwifery personnel per 100,000 population
- Number of physicians per 100,000 inhabitants
- Number of mental health practitioners per 100,000 population
- Number of hospital admissions per year
- Prevalence rate of malnutrition

- Basic sanitation meets the needs of the poorest areas
- Green spaces are satisfactory
- A website or App allows to give away unwanted items to other city residents
- Free public Wi-Fi has improved access to various services
- Number of hospitals offering/using telemedicine or related technologies
- Number of epidemiological and/or surveillance system available (such as for contact tracing)
- Number of systems for tracking the inventory and delivery of critical medical supplies

Safety, Security and Resilience

Residents live in a safe and secure community. Examples of outcomes in this area could include reduced crime rates; increased safety for women and children, and improved emergency response times. Ensuring citizens feel safe and secure and having an emergency management plan to include risk mitigation plan in case of disaster or unexpected events is another key requirement – and challenge – for all cities and communities.

Core indicators

- Crime statistics
- Mitigation and recovery plans for community resilience
- Deaths/ affected from / by disasters
- Social protection, assistance, and insurance
- Public safety in not a problem
- Percentage of inhabitants living in a zone subject to natural hazards
- Average response time for Emergency Services
- Natural disaster related economic losses as a percentage of the city's GDP

- Number of natural disaster related deaths per 100 000 inhabitants.
- Number of police officers per 100 000 inhabitants
- Number of firefighters per 100 000 inhabitants
- Violent crime rate per 100 000 inhabitants
- Traffic fatalities per 100 000 inhabitants
- Housing, health and social services, economic recovery, infrastructure systems, natural and cultural resources, threats and hazards identification, risk and disaster resilient assessment, and long-term vulnerability reduction

Infrastructure

Sustainable, safe and resilient buildings and civil engineering works are essential for cities to thrive in the future. Building products and materials, effective design planning, interconnectivity, energy performance, the protection against climate change and disasters, test methods for resilience and quality, information management in construction, ergonomically / green buildings and more shall be considered.

Core indicators

- Predictive maintenance
- Convergent networks
- Wireless retrofits
- Integrated building management systems in public buildings
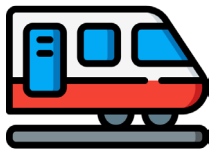
Transportation and Mobility

Residents can move freely within their community. Examples of outcomes in this area could include utilization of environmentfriendly transportation; increased accessibility to public transportation; reduced first mile/last mile gaps; reduction of congestion; road traffic safety management system aimed at organizations that interact with the road traffic system to reduce death and serious injuries related to road traffic crashes which they can influence.

Core indicators

- Length and % of transport / road network covered by websites/over-theair services offering traffic and travel information
- Number and % of urban public transport stops for which dynamic traveler information is made available to the public.
- Length and % of road network covered by the following. Report separately:
    1) Information gathering infrastructures
    2) Traffic information services
    3) Traffic management plan(s) incl. cross border TMP
    4) Traffic management and control measures /equipment
    5) Infrastructure or equipment on the network to enable Cooperative-ITS
    6) Intelligent safety services for disabled and vulnerable road users
- Report separately by road type or area where possible
- Number and % of signal-controlled road intersections using adaptive traffic control or prioritization. Report separately by road type or area where possible.

- Length and % of road network covered by incident detection and incident management. Report separately by road type or area where possible.
- Length and % of road network covered by automated speed detection. Report separately by road type or area where possible.
- Number and % of new vehicles including the following intelligent vehicle features:
    1) Safety readiness
    2) Automated operation
    3) Cooperative systems
    4) Public (112) systems
    5) Private e-Call systems
- Report separately by vehicle types where possible
- Car-sharing Apps have reduced congestion
- Public transport is satisfactory
- Apps that direct you to an available parking space have reduced journey time
- Bicycle hiring has reduced congestion
- Online scheduling and ticket sales make public transport easier to use

Urban Planning

Focuses on effective land use planning. The goal is to provide a sustainable layout for the city that can support its people, as well as the provision of their citizens' basic needs, services, and infrastructure. Such a layout will be crucial in identifying the challenges that the city faces, providing evidence-based solutions that address the identified issues, and ultimately achieving sustainability and efficiency.

Core indicators

- Strategic city planning documents promoting connectivity
- Strategic city planning documents promoting integration &mixed urban land use
- Strategic city planning documents promoting social inclusion
- Strategic city planning documents resilience to climate change

Empowerment and Inclusion

Residents are supported and given the opportunity to participate in the community through the provision of business opportunities to promote a sustainable community. Examples of outcomes in this area could include: reduced homelessness rates; reductions in the number of institutionalized children and youth; better integration of newcomers, refugees, youth, seniors, visible minorities, marginalized members in the community; opportunities to participate in, and to be informed about, the democratic process/decisions affecting the community, among others.

Core indicators

- Percentage of inhabitants living in slums, informal settlements or inadequate housing
- Ratio of average hourly earnings of female to male workers

- Percentage of the eligible population that voted during the last municipal election
- Percentage of pre-school age children (0-3) covered by (public and private) daycare centers
- Social class indicator/s

ISO Standards and Key Indicators for Smart City

- ISO 37100. Sustainable cities and communities – Vocabulary
- ISO 37120. Sustainable development in communities – Indicators for city services and quality of life
- ISO 26000. Guidance on social responsibility
- ISO 17742. Energy efficiency and savings calculation for countries, regions and cities
- ISO 39001. Road traffic safety (RTS) management systems
- ISO 39002. Good practices for implementing commuting safety management
- ISO 24510. Activities relating to drinking water and wastewater services – Guidelines for the assessment and for the improvement of the service to users
- ISO 24511. Wastewater utilities
- ISO 24512. Drinking water utilities
- ISO 20325. Guidelines for stormwater management in urban areas
- ISO 24516 Series. Guidelines for the management of assets of water supply and wastewater systems
- ISO 24518. Crisis management of water utilities
- ISO/IEC 30182. Smart city concept model – Guidance for establishing a model for data interoperability
- ISO/IEC 21972. Information technology – An upper level ontology for smart city indicators
- ISO/IEC 27550. Information technology – Security techniques – Privacy engineering

- ISO/IEC 27551. Information technology – Security techniques – Requirements for attribute-based un-linkable entity authentication
- ISO/TS 37151. Smart community infrastructures – Principles and requirements for performance metrics
- ISO/TR 37152. Smart community infrastructures – Common framework for development and operation
- ISO 22313. Societal security – Business continuity management systems – Guidance, designed to support an organization's viability and productivity in times of crisis. We also have many standards in development for community resilience, such as:
  - ISO 22327. Security and resilience – Emergency management – Guidelines for implementation of a community-based landslide early warning system
  - ISO 22395. Security and resilience – Community resilience – Guidelines for supporting community response to vulnerable people
- IWA 18. Framework for integrated community-based life-long health and care services in aged societies
- ISO/IEC Guide 71. Guide for addressing accessibility in standards
- ISO 45001. Occupational health and safety management systems

Role of major stakeholders

Local Government Units

LGU participation will be invaluable in furthering use cases in smart sustainable communities and cities. LGUs will help disseminate and laymanize its principles through a government adopter, with whom collaborations with DOST, academe, and researchers may be less complicated to obtain.

Industries

Large companies need to be open to tapping the potential that academe and researchers have, even outside their own company. In order to take advantage of the opportunities academe and researchers can provide in terms of talent and innovation, companies need to dialogue with them, allow some level of access and exposure to their operations, and where feasible, share facilities.

SMEs

The agility and flexibility of SMEs allow for emerging innovations to be more easily integrated into their operations.

Academe

Researchers and academic institutions actively participate in the implementation of R&D projects and transfer of know-hows through collaborative activities and capacity building.

Department of Science and Technology

To expedite the development of smart sustainable cities and communities in the Philippines, special funding from the department is needed for researches that has no industry applications yet but has the potential of being a gamechanger in the future. For technologies ready for industry application, the department can help bridge the gap/s between technology providers and users. Some roles that DOST must fulfill are as follows:

- Fund research efforts for various applications
- Initiate partnerships to expedite development with the LGUs and targeted industries
- Pilot implement and promote data sharing and utilization

Desired Outcomes for a Smarter City

Government Efficiency
Governance effectiveness and ease of doing business

Economic Development
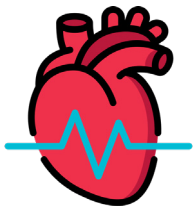Business, employment and productivity

Sustainability
Environmental, energy, water and air quality management

Public Safety
Welfare and protection from crime, hazards and disasters

Health and Wellness
Mental, physical and social care and wellbeing

Quality of Life
Welfare and protection from crime, hazards and disasters

Mobility
Mental, physical and social care and well-being

References:

ISO and Smart Cities. 2017. Geneva, Switzerland. ISBN 978-92-67-10776-9. URL: http://www.iso.org

Smart City Index. 2019. The IMD World Competitiveness Center

Smiciklas, J. 2019. U4SSC Key Performance Indicators for Smart Sustainable Cities. Minsk. United for Smart Sustainable Cities Initiative (U4SSC). URL: https://www.itu.int/en/ITU-D/Regional-Presence/CIS/Documents/Events/2019/02_Minsk/Presentations/Training-S1-and-S2-Pres2-SmiciklasJohn-U4SSC_KPIs-John-Smiciklas.pdf

Acknowledgements:

Contact us:

DOST

DOST-PCIEERD

ENGR. SANCHO A. MABBORANG
DOST Undersecretary for Regional Operations
1/F ADMATEL Building, DOST Compound, Gen. Santos Avenue, Bicutan, Taguig City
Telephone Nos.: (02) 8837 2941; (02) 8837 2071 to 82 local 2025
Email: samabborang@dost.gov.ph; ousec.ro@dost.gov.ph
website: www.dost.gov.ph

DR. ENRICO C. PARINGIT
Executive Director
Philippine Council for Industry, Energy and Emerging Technology
Research and Development
4th and 5th Floors, Science Heritage Building, DOST Science Complex, Bicutan, Taguig City
Tel: (02) 837-2071 to 82 local 2106
Email: enrico.paringit@pcieerd.dost.gov.ph
Website: www.pcieerd.dost.gov.ph