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Sustainable cities and communities — Guidance for managing a public-health emergency response in smart city operating models

Villes et communautés territoriales durables — Recommandations pour la gestion d'une réponse d'urgence en matière de santé publique dans les modèles d'exploitation des villes intelligentes

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Foreword

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This document was prepared by Technical Committee ISO/TC 268, *Sustainable cities and communities.*

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Managing public-health emergencies (PHEs) and eliminating their impact on sustainable development has become a common challenge for all countries in the world. In recent years, various types of PHEs [e.g. Ebola virus disease (EVD) in West Africa, the Middle East Respiratory Syndrome (MERS), Zika virus disease, COVID-19 and monkeypox], have caused severe consequences to countries around the world. This has critically challenged the public-health emergency management (PHEM) systems of many countries, especially developing countries. Eliminating the impact of sudden public-health events is an important goal for achieving sustainable development globally.

The rapid development of the internet, Internet of Things (IoT), artificial intelligence (AI), cloud computing and other information and communication technologies are accelerating change across the economy and society at large. In smart cities and communities, new network facilities, new data environments, and new technology applications offer the potential to transform the effectiveness of PHEM. This enables monitoring and analysis, virus tracing, prevention and control treatment, resource allocation and other aspects of PHEs, to be managed more quickly. It also allows more efficient and transparent reporting systems, and more effective medical, social and economic outcomes.

Equally, however, technology can only make a difference when accompanied by innovative ways of working through smart governance processes, supported by interoperable standards that enable organizations to collaborate in new ways to deliver integrated action, efficiently, effectively and at scale. This is done through partnership across the public sector and private sector, and across local, regional, national and international levels of government.

This document brings together practical recommendations to community authorities on how to plan and deliver this type of smart response to PHEs, combining innovation in technology with innovation in governance processes. These recommendations are designed to be flexible, enabling tailored implementation by the local governments of cities and communities in ways that recognize their unique situation and policy context.

This document helps leaders of cities and communities to:

— use smart technologies, following the principles of ISO 37106, to manage relevant facilities and resources for PHEs, enabling dynamic real-time monitoring and management of relevant data;

— support a more effective response to PHEs and promote more effective cooperation among all interested parties, based on each stage of the command-and-control process for emergency management and incident response set out in ISO 22320;

— help cities to assess the current level of maturity of a PHE response in smart city operating models;

— improve urban resilience so that the cities or communities can adapt to all risks in PHEs and lead towards sustainability with the help of smart city operating models.

NOTE This document was informed by research from cities around the world on how smart operating models supported effective responses to the COVID-19 pandemic, as described in ISO/TR 37112.

The document is structured as follows:

— Clause 1 describes the scope;

— Clause 2 lists normative references;

— Clause 3 sets out the terms and definitions used in the document;

— Clause 4 illustrates the framework for smart city operating models in response to PHEs;

— Clause 5 describes how to implement smart city operating models in response to PHEs;

— Clause 6 describes the way to improve the maturity of smart city operating models in response to PHEs within a community;

— Annex A describes the maturity model for smart city operating models in response to PHEs.

Sustainable cities and communities — Guidance for managing a public-health emergency response in smart city operating models

1 Scope

This document provides guidance to community authorities on how to use smart technologies and smart ways of working to improve their ability to anticipate, manage and mitigate public-health emergencies (PHEs), including through transparent, interactive and citizen-centric communications with citizens. It does this by demonstrating how the principles and good practices for smart city operating models recommended in ISO 37106 can deliver improved outcomes in public-health emergency management (PHEM), at every stage of the command-and-control process for emergency management and incident response set out in ISO 22320.

This document sets out recommendations for community authorities and provides tools that can be used to assess the maturity of community systems for smart PHEM.

This document applies to all types of cities and communities that are willing to apply smart city operating models to respond to PHEs.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 37100, *Sustainable cities and communities — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 37100 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
public-health emergency
PHE
sudden occurrence of major infectious diseases, diseases of unknown causes, major food and water and occupational poisoning and other events that seriously affect and cause, or can cause, damage to public-health

3.2
public-health risk
likelihood of an event that can adversely affect the health of the human population, with an emphasis on one which can spread internationally or can present a serious and direct danger

4 Framework for smart city operating models in response to PHEs

This document supports the United Nations Sustainable Development Goals (UN SDGs) of making cities and human settlements inclusive, safe, resilient and sustainable, and is an enabler for all six strategic purposes of a sustainable community described in ISO 37101. It does so by providing an overall framework for smart city operating models in response to PHEs, as summarized in Figure 1.

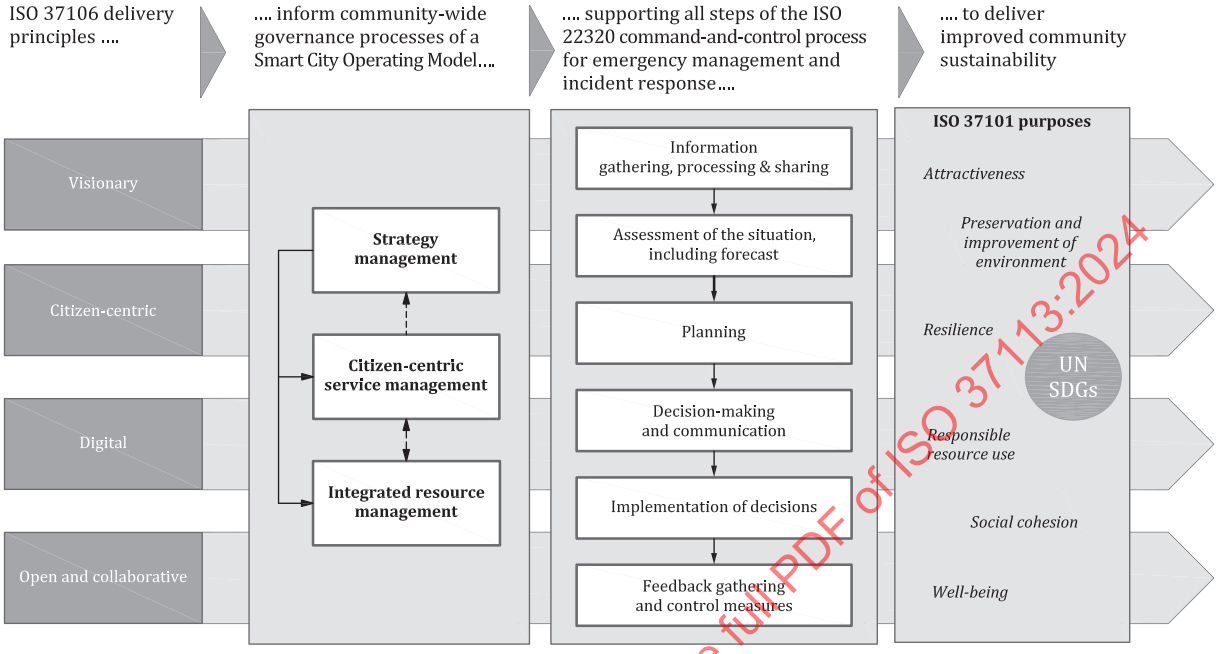

Figure 1 — Framework for smart city operating models in response to PHEs

In particular, this document:

a) is informed by the four delivery principles for a 'smart city operating model' described in ISO 37106:

   1) establishing a clear, compelling and inclusive vision for the sustainable future of the community;

   2) taking a citizen-centric approach to all aspects of service design and delivery;

   3) enabling a ubiquitous, integrated and inclusive digitization of community spaces and systems;

   4) embedding openness and collaboration in the way the community works;

b) provides recommendations for community authorities on how each of the three community-wide governance processes for a smart city operating model established by ISO 37106 (e.g. strategy management, citizen-centric service delivery, and digital and physical asset management) can support more effective PHEM at each stage of the command-and-control process for emergency management and incident response set out in ISO 22320:

   — information gathering, processing and sharing;

   — assessment of the situation, including forecasting;

   — planning;

   — decision-making and communication;

   — implementation of decisions;

   — feedback and control measures (which also covers monitoring and evaluation).

Although Figure 2 illustrates the ISO 22320 command-and-control process as a simplified, linear one, in practice it is a non-linear process with multiple feedback loops across multiple stakeholders, as illustrated in Figure 3.

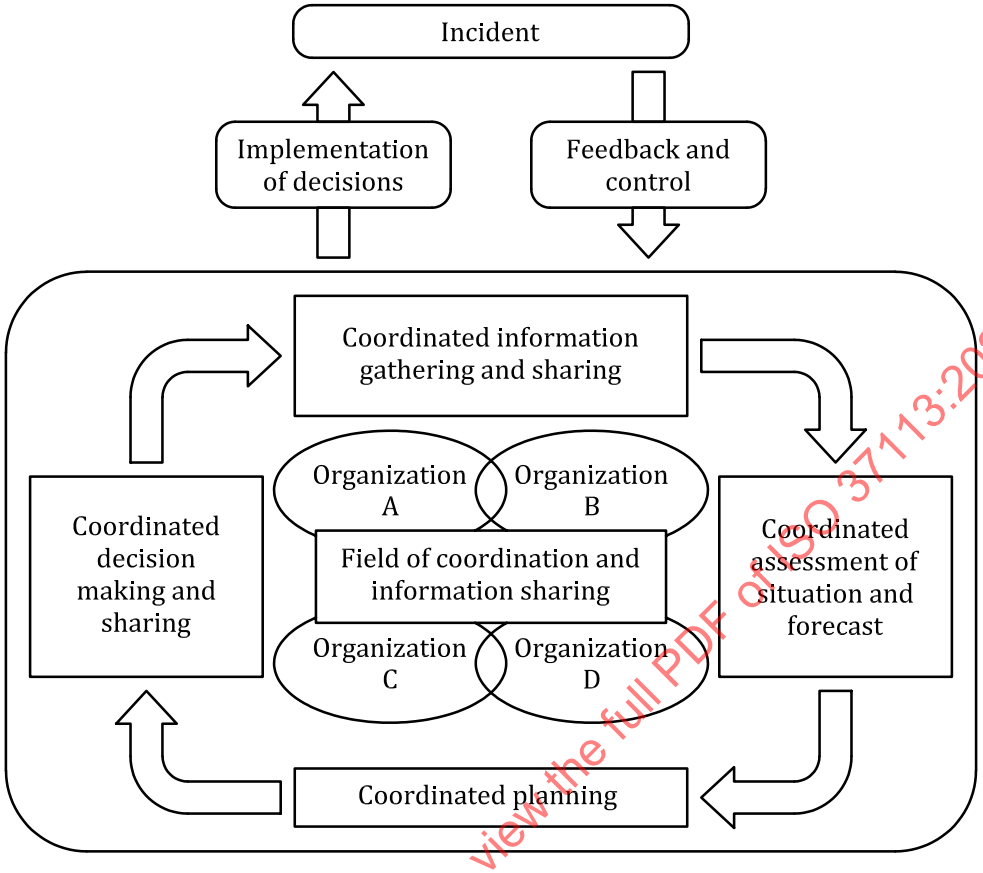

Figure 2 — Multiple stakeholder coordinated command-and-control process for emergency management and incident response

Smart PHEM uses new technologies and new ways of working to help improve each step of this process, and to facilitate speedier and more effective collaboration across the wide range of stakeholders that need to be involved at each step. Clause 5 describes these new technologies and new ways of working, and Clause 6 provides a tool to assess the maturity of a community's smart PHEM processes at each stage of the ISO 22320 command-and-control process.

5 Implementing smart city operating models in response to PHEs

5.1 Overview

ISO 37106 sets out recommendations for a smart city operating model that is focused on addressing city-wide challenges of joining up across city silos, in three areas:

— Strategy management: the key aspects of governance, planning and decision-making that need to be managed on a city-wide level in order to provide effective responses to community-wide challenges.

— Citizen-centric service management: the provision of public services for citizens and businesses that are built around user needs, accessibility, inclusivity and co-created with users.

— Integrated digital and physical resource management: ensuring that data on the performance and use of the community's physical, spatial and digital assets is available in real-time and on an interoperable basis, in order to enable real-time integration and optimization of city resources; and opening up community

data (securely and protecting privacy) in order to enable innovation by citizens, businesses and civil society.

Figure 3 below uses the "benefit mapping" methodology recommended in ISO 37106 to summarize how development of such a smart city operating model can support more effective PHEM. Subclauses 5.2 to 5.4 then look at each of the three components in turn, setting out practical recommendations for community authorities on how investments and governance changes in these areas can lead to improved PHEM outcomes. This smart city operating model ultimately supports each stage of the command-and-control process for the emergency management and incident response process to public-health emergencies.

NOTE The sixth step in the ISO 22320 command-and-control process in Figure 3 includes monitoring and evaluation.

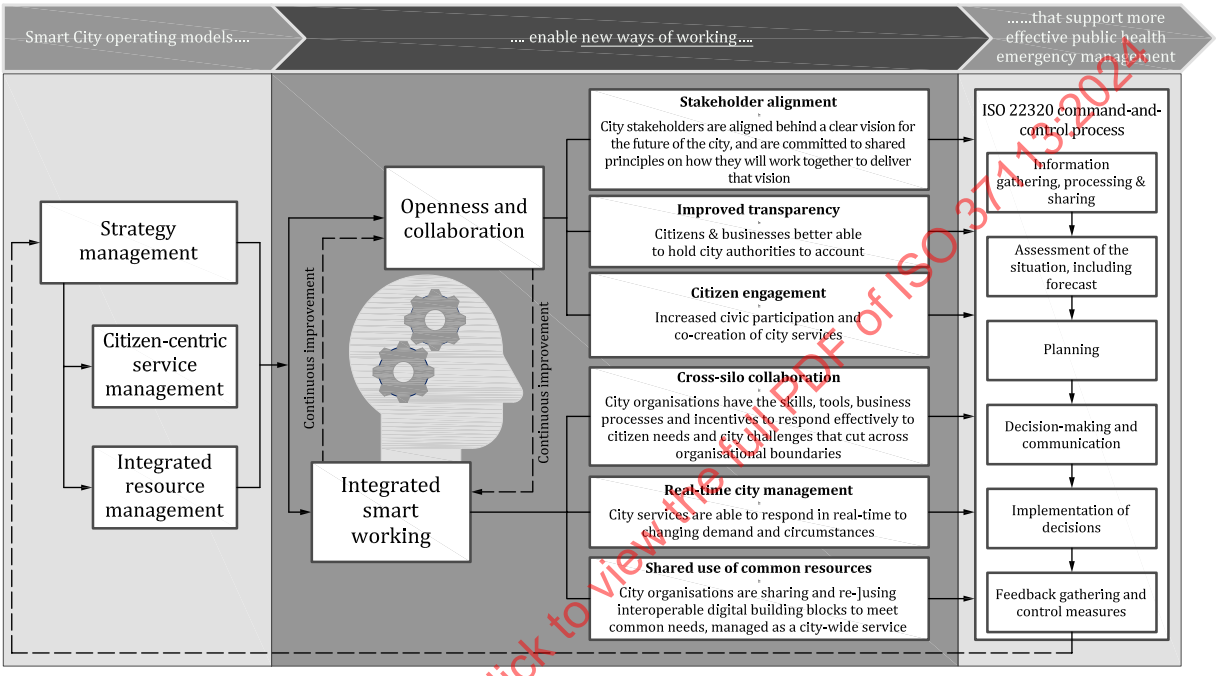

Figure 3 — How a smart city operating model supports more effective PHEM

5.2 Strategy management

5.2.1 General

ISO 37106 sets out recommendations to city leaders on strategy management for smart cities that (as summarized in ISO 37106:2021, 6.2) focus on taking a city-wide approach to:

a) establish an integrated vision, strategy and benefit realization plan;

b) underpin this with an operating model which provides strong leadership and collaborative engagement with all interested parties, balancing the need for city-wide management on the one hand and local innovation on the other;

c) take an organic approach to implementation: establishing the business processes, capacity and structures that can drive transformation and create and grow sustained improvements over time, even if all the steps of that transformational journey cannot be planned in detail at the outset.

The case study evidence from cities around the world presented in ISO/TR 37112 confirms the importance of this approach in the context of PHEM. Key cross-cutting themes across all the case studies featured in ISO/TR 37112 include:

— The importance of taking an integrated, digitally-enabled approach on a whole-chain basis: not simply implementing each individual step of the ISO 22320 command-and-control process but seeking to manage

the different steps of that process as an integrated approach with transparency and real-time feedback loops for city managers.

— The need for strong leadership and collaborative governance: All the case studies in ISO/TR 37112 highlight the need for visionary leadership at political and operational levels within the local authority, and the need for collaborative governance processes to drive co-ordination across different organizational silos. Where such processes were already in place, with existing trusted relationships, cities were able to respond far more quickly to COVID-19.

Against this context, the following subclauses set out recommendations for city and community leaders seeking to implement a city-wide strategic management system for smart PHEM.

5.2.2 Leadership and governance

Leaders of smart cities and smart communities should establish leadership and governance arrangements for smart PHEM that ensure:

a) a clear focus of accountability within the local authority;

b) a broad-based leadership team, ensuring that leaders from integrated health, social care and wider community services are brought together;

c) development of visionary goals in an iterative manner with a wide range of stakeholders in the short- and long-term scales for smart cities to respond to PHEs;

d) a programmatic approach to identifying and keeping under review the risks associated with PHEs through development of policies for PHEs, and commitment to allocation of appropriate resources to develop, implement and continuously improve the policy system;

e) documented operating procedures for PHEM, with clear instructions, systematic and orderly, smooth and effective execution, and accurate problem solving;

f) integration of PHEM and broader resilience considerations into urban planning.

5.2.3 Collaborative engagement

Leaders of smart cities and smart communities should establish collaborative engagement arrangements for smart PHEM that ensure:

a) engagement of all stakeholders via inclusive and collaborative governance processes, underpinned by effective data sharing;

b) definition and mapping of all key interested parties and their responsibilities, including but not limited to: management departments, medical and health institutions, academic and research institutes, non-governmental organizations, the private sector, community managers and citizens, overseas visitors and workers and the media;

c) use of digital platforms to share information between the local authorities and other interested parties, including through provision of timely, accurate and comprehensive data on progress of the PHE and of the community's response;

d) effective collaboration between the community, regional and national levels, to achieve sharing of information, emergency resources, joint protection of emergency material production, and linkage of major emergency strategies and measures;

e) development of a zonal and hierarchical PHEM strategy using smart technologies such as Geographic Information Systems (GIS).

5.2.4 Integrated planning on a whole-chain basis

Leaders of smart cities and smart communities should establish integrated planning arrangements for smart PHEM that ensure:

a) PHE plans take a whole-chain approach across all elements of the ISO 22320 command-and-control process;

b) a holistic strategy embracing health, social and economic interventions, such as monitoring information, personnel movement, preparing stockpile emergency supplies and assuring price stability;

c) evidence-based decision making on the characteristics and needs of the whole-chain management for PHEs and determining the priority of actions;

d) refinement of the relevant modules of the smart city system to enable data exchange and data sharing between local community and others such as districts, regions or cities, whilst respecting identity and privacy management (5.3.4);

e) transparent reporting on whole-chain management, measurement and performance evaluation for PHEs;

f) cross-silo collaboration;

g) improved self-organization of local communities to link up the smart services between local community and city;

h) post-emergency evaluation aimed at reviewing lessons learned and identifying medium-term and long-term impacts of strategic and operational decisions that should be taken into account in updated PHE plans.

5.2.5 Capacity building and skills management

Leaders of smart cities and smart communities should establish integrated planning arrangements for smart PHEM that ensure:

a) capacity building for public-health and epidemic/pandemic prevention to cope with major PHEs that:

   — includes risk analysis and assessment of PHEs, emergency planning, resource allocation, testing, periodic assessment and improvement, and plan revision;

   — takes advantage of advanced technologies such as big data, IoT and AI.

b) long-term training and exercise systems for personnel and response agencies, in order to further promote the build-up of digital tools for responding to PHEs;

c) incorporation of the principles and practices recommended in this document within the handbooks and procedural manuals of the organizations concerned.

5.2.6 Procurement and supplier management

Leaders of smart cities and smart communities should establish procurement and supplier management arrangements for smart PHEM that ensure:

a) integrated transportation and logistics, supported by an integrated emergency logistics information platform to ensure supply chain for PHEs through smart technology such as big data and IoT;

b) establishment and maintenance of an information system of suppliers to ensure transparency, safety and sustainability of the emergency procurement;

c) development of smart emergency logistics plans, supported by practical testing to ensure the emergency logistics and supply chain are resilient to public-health risks;

d) cultivation of protective awareness of transportation personnel in the distribution and transportation of goods and products for PHEs, as well as epidemic prevention and disinfection of materials and transportation vehicles.

5.3 Citizen-centric service delivery

5.3.1 General

ISO 37106 sets out recommendations to city leaders on citizen-centric service delivery, characterized by:

a) delivery of integrated services that are built around user needs, co-created with users and accessible in one stop over multiple channels;

b) empowering interested parties of all kinds across the city to create new kinds of services and value, by opening up city data via open platforms;

c) development of a "citizen-centric trust model" to support privacy-protective use of integrated data within a secure, federated IT and governance architecture;

d) encouraging access and use of digital services by citizen and business groups, including those currently excluded from these services for whatever reason.

The case study evidence from cities around the world provided in ISO/TR 37112 confirms the importance of this approach in the context of PHEM. The case studies highlight the importance of putting citizens at the centre of the city's planning and delivery for PHE, and the importance of openness and transparency in building trust and engagement. Linked with this openness is a need to put protection of individual privacy at the heart of the process, and to be transparent in how this is managed.

Against this context, the following subclauses set out recommendations for city and community leaders seeking to implement a citizen-centric approach for smart PHEM.

5.3.2 Underpinning PHE response with a detailed understanding of citizen needs

Leaders of smart cities and smart communities should establish citizen insight arrangements for smart PHEM that ensure:

a) detailed and evidence-based segmentation of the different citizen groups impacted by the PHE;

b) ongoing investment in citizen insight to understand how citizen needs change through the course of the PHE;

c) a co-design / co-creation approach is taken to interventions that impact directly on citizens;

d) any specific additional needs of users who might need assistance in engaging digitally with measures for PHEs response have been identified;

e) effective and interactive communication services for visitors during PHEs, enabling visitors easily to understand and engage with the city's policy when responding to PHEs.

5.3.3 Empowering citizens through information-sharing, transparency and public accountability

Leaders of smart cities and smart communities should establish citizen communication arrangements for smart PHEM that ensure:

a) communication with citizens about plans and progress in all aspects of planning for and management of PHEs;

b) investment in data sharing and interoperability across relevant public sector and private sector platforms;

c) establishment of digitally-enabled models of public participation, with appropriate support for any groups that can have difficulty in participating with these;

d) establishment of a tiered medical and response information sharing mechanism for PHEs;

e) establishment of an integrated information platform for social management through technical support and information support to achieve the goals of epidemic monitoring and analysis, virus tracking, prevention and control, resource allocation.

5.3.4 Providing integrated citizen-centric services

Leaders of smart cities and smart communities should establish citizen service delivery arrangements for smart PHEM that:

a) provide one-stop, multi-channel public smart services to citizens and businesses, such as online application for enterprise resumption of work, online education services, and e-commerce platforms;

b) establish a smart emergency platform to provide emergency medical treatment and dispensing services to emergency seekers;

c) provide convenient guidance for citizens to choose staggered travel, such as creating a heat map of the region's population;

d) establish information sharing and services platform for different categories of volunteers, such as volunteers for local delivery within communities, and volunteers for service for elders, children and other persons who need special attendance and protection and volunteers assisted for medical personnel;

e) establish a platform for mutual recognition of epidemic prevention information amongst countries to facilitate cross-border travel;

f) implement smart verification technology at the entrance and exit of various key locations.

5.3.5 Identity and privacy management

Leaders of smart cities and smart communities should establish identity and privacy management arrangements for smart PHEM that:

a) establish a secure sharing mechanism between different organizations and agencies regarding citizens' private data, with documented protocols for cross-agency sharing of relevant personal health information in ways that both support rapid interventions and are consistent with national data protection regulations;

b) ensure citizen privacy and data security, with all personal data securely protected under the ownership and control of citizens;

c) open up PHE data for use by community to the maximum extent compatible with security and privacy.

5.4 Integrated management of digital and physical resources

5.4.1 General

ISO 37106 sets out recommendations to city leaders on integrated management of digital and physical resources, characterized by:

a) integration of smart city principles into the planning, construction and management of the city's built environment and physical infrastructure;

b) management of key digital technology and data assets as a city-wide resource rather than within individual silos;

c) development of an open, service-oriented, city-wide IT architecture based on shared platforms.

The case study evidence from cities around the world provided in ISO/TR 37112 confirms the importance of this approach in the context of PHEM. All the cities featured in ISO/TR 37112 had, to at least some extent, previously invested in development of integrated city data models and of shared platforms that enable

privacy-protective data-sharing on a cross-organizational basis. Although these existing platforms and data models often needed enhancing to address the specific challenges of COVID-19, they provided an important base on which to build.

Against this context, the 5.4.2 to 5.4.5 set out recommendations for city and community leaders seeking to implement integrated management of digital and physical resources for smart PHEM.

5.4.2 Smart enablement of city infrastructure

Leaders of smart cities and smart communities should establish infrastructure planning and management arrangements that:

a) manage resource and dynamic application scenarios in smart city systems through measures such as digital footprints and city information models (CIMs);

b) manage new technologies and digital assets for effective reuse;

c) ensure the provision of services in cities and communities, such as energy, water, communications, and transportation in response to PHEs;

d) enhance the information and communications technology (ICT), such as IoT and big data collection, to improve information collaboration and dissemination of information in the local community;

e) establish common protocols for data sharing and interaction with infrastructure service providers;

f) configure supporting facilities for data security supervision;

g) promote smart market management during PHEs, such as product quality, service, and personnel supervision, by using big data and other technologies.

5.4.3 Integration and sharing of data resources

Leaders of smart cities and smart communities should establish data management arrangements that:

a) Map out and prioritize key data resources across the city (including demographics, information on vulnerable groups, geospatial information, transportation and logistics data) that can be helpful in identifying, preventing and controlling PHEs.

b) For each key PHE data resource, ensure this is:

   1) identified and managed as a distinct, valued asset by an explicitly-designated owner;

   2) associated with clear policies and processes for reuse, particularly across ownership domains.

c) Provide common data platforms, supported by interoperable data standards, that enable:

   1) secure data sharing and collaboration between all agencies that need to be involved in the PHE response;

   2) publish as much open data on progress and management of the PHE as is possible within the constraints of protecting individual privacy.

5.4.4 Real-time management of emergency response to PHEs

Leaders of smart cities and smart communities should establish arrangements to ensure that PHEM can be informed by real-time or near real-time data in areas including, but not limited to, the following:

a) dynamic recording and filing of urban space and idle physical assets (e.g. spaces, public facilities, public buildings, and unoccupied assets throughout the city, such as stadiums, schools, hospitals, office buildings);

b) provision of information for stakeholders (e.g. the location of open medical facilities, telemedicine, services for elders, children and other persons who need special attendance and protection, volunteers assisted for medical personnel, and pet care information and services);

c) monitoring and management of transportation facilities and traffic flows;

d) allocation and quality assurance of living products, medicines, instruments and equipment, enabling accurate matching of information on supply and demand;

e) monitoring and management of the distribution and flow of population in the city/community, and strengthening the management of the distribution and flow of people at risk;

f) monitoring and managing wastewater and waste-pollution during PHEs;

g) accurate matching of volunteers with volunteering opportunities, supported by user-friendly application services for volunteers;

h) assessment of risks to smart city management and strengthening smart security in response to PHEs, such as handling of loss of cell phone signals and malicious internet attacks;

i) monitoring of hazardous events, other than, or simultaneous with, a PHE that can affect emergency or disaster management.

5.4.5 Improved decision-making

Leaders of smart cities and smart communities should establish decision-making arrangements for PHEM that:

a) provide information support for decision-making for PHE responses;

b) promote emergency management information collaboration by applying information technology tools (e.g. IoT, cloud computing, AI, big data, mobile internet, blockchain);

c) guide personal travel by using algorithms for citizens in PHE responses;

d) use smart verification technologies at the entrances and exits of key locations, such as "health codes";

e) establish monitoring and evaluation processes to establish the impact of decisions and inform future decision-making, following the "feedback and control" best practices in ISO 22320.

6 Improving the maturity of smart city operating models in response to PHEs within a community

The local authorities should work with community stakeholders to:

— evaluate the current levels of maturity for each part of the PHE system, by using a maturity model developed using the ISO 37153 methodology and the six steps of the command-and-control process in ISO 22320;

— establish plans to continuously improve the suitability, adequacy and effectiveness of the system, and a roadmap for desired outcomes;

— track progress in moving further along the maturity path.

Depending on the agreed evaluation concept, both quantitative and qualitative data are requested. Data can be collected based on indicators for each of the issues selected and depends on the specific PHEM plan and maturity roadmap developed by the community.

Evaluation is a planned, systematic process that compares the achievement with commitments and requirements. It assesses the efficiency, effectiveness, and appropriateness of actions. Evaluation generally consists of comparing the information available before and after project implementation, e.g. to assess behavioural change in interested parties, or improvement in environmental performance. Depending on the evaluation, quantitative or qualitative data are required.

Annex A provides a high-level, qualitative maturity model for use by communities in initial development of their own PHEM maturity model and improvement roadmap. This has been designed to align with the ISO/TS 37107 maturity model for smart sustainable communities, which applies the ISO 37153 methodology for smart community maturity modelling to the community-wide "smart city operating model" described in ISO 37106. The maturity model in Annex A identifies different levels of maturity in applying smart operating processes for each of the areas of recommendation in Clause 5 of this document.

Annex A
(informative)

Maturity model for smart city operating models in response to PHEs

The evaluation matrix in Table A.1 uses the ISO 37153 methodology for smart community maturity modelling to define qualitative maturity levels for smart city operating models in response to PHEs for each area of recommendation in this document. It uses the following definitions for each of the five levels of maturity recommended in ISO 37153, tailored to the specific context of smart PHEM:

- **Level 1: Initial** — Processes to manage these good practices either do not exist or are managed on a fragmented basis by different community organizations.
- **Level 2: Partially fulfilled** — Some progress is being made towards implementation of these good practices, but not within a consistently applied community-wide management framework that reflects extensive consultation with interested parties.
- **Level 3: Fulfilled** — The community has established community-wide management processes to deliver good practices in this area, and these reflect extensive consultation with interested parties.
- **Level 4: Improving** — The community can demonstrate that it is measuring the performance of these processes, that it is engaging interested parties effectively in their governance, and that positive impacts are being achieved.
- **Level 5: Sustainably optimizing** — The community can demonstrate clear evidence of systemic continual improvement.

Users of the evaluation matrix are recommended to assess their community's maturity, at the following periods:

- now: which of the achievement criteria given in Table A.1 best describes the community's current performance for each area of recommendation in this document?
- in two years: based on current plans that community leaders have already put in place, would the community be expected to meet a higher level of achievement criteria in two years' time?

This dual assessment will give an overview of both current strengths and weaknesses, and of where there are key gaps in existing plans for improvement.

To determine the average score for each of the three areas of recommendation covered by this document (i.e. strategy management, citizen-centric service delivery, and integrated management of physical and digital resources), all of the individual scores for the recommendations in that area should be added up and then divided by the number of recommendations. The three summary scores that result can then be further summarized into a single overall maturity score for smart PHEM, by adding them and dividing them by three. These mid-level and high-level summary scores can be used to give a simple overview of how a community progresses over time or compares with another community, but it is the detailed recommendation-level scores that will be more useful in guiding action by the community.

Table A.1 — Maturity levels for Smart Public-Health Emergency Management (PHEM)

	Maturity level					Assessment
	1: Initial	**2: Partially fulfilled**	**3: Fulfilled**	**4: Improving**	**5: Sustainably optimizing**	
Strategy management: ISO 37113 Clause in this document						
Leadership and governance (5.2.2)	There is no clear focus of accountability within the local authority for PHEM at a community-wide level.	A clear focus of leadership and accountability for PHEM has been established within the local authority, but the people involved are not empowered with the authority, clear operating procedures for PHEM, and resources needed to make significant impact during a PHE.	A clear focus of leadership and accountability for PHEM at a community-wide level has been established within the local authority, bringing together leaders from health, social care, and wider community services. The people involved are empowered with the authority, clear operating procedures for PHEM, and resources needed to make significant impact during a PHE.	In addition to the achievement criteria indicated at level 3, real-time or near real-time information systems give community leaders full transparency on the PHE and allow for transparent and collaborative data-led decision making.	In addition to the achievement criteria indicated at level 4, PHEM and broader resilience considerations are integrated into urban planning. A programmatic approach to identifying and reviewing potential PHE risks supports a continual review and improvement of the policy system.	Level now: Level in two years based on current plans:
Collaborative engagement (5.2.3)	There is no community-wide programme of communication and engagement with interested parties about how the community should plan for and manage PHEs.	The local authority has established a formal, community-wide programme of communication and engagement with interested parties about how the community should plan for and manage PHEs.	In addition to the achievement criteria indicated at level 2, there is clear evidence that an inclusive and digitally-enabled approach is being taken, underpinned by effective data sharing.	In addition to the achievement criteria indicated at level 3, there is evidence of effective collaboration between the community, regional, and national levels, to achieve sharing of information and resources during a PHE.	In addition to the achievement criteria indicated at level 4, there is clear, publicly available evidence of how the views of interested parties are shaping the development and implementation of the community's PHE vision and strategy, and feedback systems have been put in place to facilitate ongoing dialogue between interested parties about future plans.	Level now: Level in two years based on current plans:
Integrated planning on a whole-chain basis (5.2.4)	There are no integrated planning arrangements for smart PHEM within the community.	There are integrated planning arrangements for smart PHEM within the community, embracing health, social, and economic interventions.	In addition to the achievement criteria indicated at level 2, there is transparent reporting on whole-chain management, measurement, and performance evaluation for PHEs, allowing for evidence-based decision making regarding the needs and priorities of the whole-chain management for PHEs.	In addition to the achievement criteria indicated at level 3, a cross-silo collaborative approach has been adopted, enabling data exchange and data sharing between key partners.	In addition to the achievement criteria indicated at level 4, real-time feedback loops have been integrated to ensure optimisation regarding planning on a whole-chain basis.	Level now: Level in two years based on current plans:

Table A.1 *(continued)*

	Maturity level					Assessment
	1: Initial	**2: Partially fulfilled**	**3: Fulfilled**	**4: Improving**	**5: Sustainably optimizing**	
Capacity building and skills management (5.2.5)	There is no capacity building or training in place regarding PHEs.	The community is taking some active steps towards capacity building for public-health and epidemic/pandemic prevention to cope with major PHEs, such as risk analysis, emergency planning, resource allocation, and developing internal skills.	In addition to the achievement criteria indicated at level 2, the community is embedding long-term training and exercise systems for personnel and response agencies to promote the build-up of digital tools for responding to PHEs.	In addition to the achievement criteria indicated at level 3, the community is taking advantage of advance technologies such as big data, IoT and AI to expand their capacity for future PHEM.	In addition to the achievement criteria indicated at level 4, testing and periodic assessment allow for improvement and revision of existing strategies.	Level now: Level in two years based on current plans:
Procurement and supplier management (5.2.6)	There is no community-wide procurement and supplier management strategy within PHEs. Requirements are specified and purchased independently by each community organization, and the community has limited ability to fund solutions where costs and benefits fall across multiple organizations.	The local authority has established a strategy to move towards more coordinated procurement, but control mechanisms are weak. There are some examples of inter-organizational shared procurements, but these are ad hoc and driven by individual local managers.	The local authority has established community-wide policies to optimize procurement and supplier management across different local authority business units, including: — holistic and flexible budgets that can fund cross-organizational projects; — a focus on achieving best value for money for the community as a whole, rather than for an individual business unit by establishing and maintaining a shared information system of suppliers; — development of smart emergency logistics plans and supply chains, supported by practical testing to ensure these are resilient.	In addition to the achievement criteria indicated at level 3, these policies are now underpinned by clear business processes, measurements and controls to ensure compliance. Smart technology (e.g. big data, IoT) is integrated into the emergency logistics information platform to support the PHE supply chain.	In addition to the achievement criteria indicated at level 4, there is clear evidence that the community has effective mechanisms to secure feedback from community suppliers and other interested parties on the practical implementation of these policies, which it is using to drive continuous improvement.	Level now: Level in two years based on current plans: