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Smart community infrastructures — Disaster risk reduction — Survey results and gap analysis

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National foreword

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Smart community infrastructures – Disaster risk reduction – Survey results and gap analysis

Infrastructures urbaines intelligentes – Réduction des risques de catastrophes – Résultats d'enquête et analyse des écarts

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 268, *Sustainable cities and communities*, Subcommittee SC 1, *Smart community infrastructures*.

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.

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Introduction

Over the last decade, global communities have made great progress towards reducing disaster risk through strengthening resilience against natural hazards. However, in addition to geological hazards, ongoing climate changes can exacerbate existing hydrometeorological hazard risks by increasing the frequency and intensity of these hazards, in either unprecedented combinations and/or unexpected locations. As a result, more communities and assets can be exposed to these hazards, leading to greater damage by disasters.

In order to protect communities against natural hazard risks, infrastructures can play a key role in strengthening resilience. Critical infrastructures that communities rely on, such as energy, information and communication technologies (ICT), transportation, waste and water, and other infrastructures affect vital community functions such as livelihoods, medical activities, financial services. This results in an increasing cost of disasters for all sectors of the community whether it is governments, businesses, and individuals. These costs include not only direct costs but also indirect ones such as costs from flow-on effects from disasters. Through the implementation of infrastructure that can strengthen resilience, communities can recover from the impacts of disasters quickly and effectively.

The demand for smart community infrastructures, as scalable and integrable products, will continue to grow in the decades ahead. However, it is imperative that such infrastructures can also be designed in a way that reduces disaster risk and strengthens disaster resilience. Through an analysis of existing documents on smart community infrastructure for disaster risk reduction and a survey of global examples, this document is intended to identify existing gaps in the implementation of smart community infrastructure for disaster risk reduction, and to identify topics for potential areas in the standardization of smart community infrastructures for disaster risk reduction. Through the accumulation of global best practices, this document identifies areas for potential standardization, which includes but is not limited to, the strengthening of disaster risk reduction technologies utilized in critical infrastructures such as energy, waste and water, transportation, ICT, and the built environment. This document seeks to provide the foundation for future standardization deliverables which promote the interoperability of disaster risk reduction technologies globally.

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Smart community infrastructures – Disaster risk reduction – Survey results and gap analysis

1 Scope

This document identifies existing global smart community infrastructures that enhance disaster risk reduction, the key purposes served by these global examples, gaps in coverage, and the need for standardization activities, which establishes the basis for the next steps for standardization.

This document is intended to be a basis for the future standardization of smart community infrastructures for disaster risk reduction through the identification of areas for potential standardization. This includes, but is not limited to, infrastructures related to energy, waste and water, transportation, information and communication technologies (ICT), and the general built environment.

It does not address specifications or requirements already covered by other relevant international standards.

This document primarily addresses disasters caused by natural hazards, such as geological and hydrometeorological hazards, and does not focus on human-induced disasters such as terrorism or biological hazards such as pandemics.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
community
group of people with an arrangement of responsibilities, activities and relationships

Note 1 to entry: In many, but not all, contexts, a community has a defined geographical boundary.

Note 2 to entry: A city is a type of community.

[SOURCE: ISO 37120:2018, 3.3]

3.2
community infrastructure
systems of facilities, equipment and services that support the operations and activities of communities

Note 1 to entry: Such community infrastructures include, but are not limited to, energy, water, transportation, waste and information and communication technologies (ICT).

[SOURCE: ISO 37100:2016, 3.6.1]

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3.3
critical infrastructure
physical structures, facilities, networks and other assets which provide services that are essential to the social and economic functioning of a *community* (3.1) or society

Note 1 to entry: Examples of critical infrastructure can include, but are not limited to, power generation, transmission and distribution, water treatment, distribution and drainage, wastewater and stormwater infrastructure, transportation, gas supply and distribution, telecommunications infrastructure, educational facilities, hospitals and other health facilities.

[SOURCE: ISO 37123: 2019, 3.1]

3.4
disaster
serious disruption to a city or *community* (3.1) due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to human, material, economic and/or environmental losses and impacts

Note 1 to entry: Disasters can be frequent or infrequent, depending on the probability of occurrence and the return period of the relevant *hazard* (3.5). A slow-onset disaster is one that emerges gradually over time, for example through drought, desertification, sea level rise, subsidence or epidemic disease. A sudden-onset disaster is one triggered by a hazardous event that emerges quickly or unexpectedly, often associated with earthquakes, volcanic eruptions, flash floods, chemical explosions, *critical infrastructure* (3.3) failures or transport accidents.

[SOURCE: ISO 37123:2019, 3.2]

3.5
hazard
phenomenon, human activity or process that can cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation

Note 1 to entry: Hazards include biological, environmental, geological, hydrometeorological and technological processes and phenomena. Biological hazards include pathogenic microorganisms, toxins and bioactive substances (e.g. bacteria, viruses, parasites, venomous wildlife and insects, poisonous plants, mosquitoes carrying disease-causing agents). Environmental hazards can be chemical, natural, radiological or biological, and are created by environmental degradation, physical or chemical pollution in the air, water and soil. However, many of the processes and phenomena that fall into this category can be "drivers" of hazard and risk rather than hazards themselves (e.g. soil degradation, deforestation, biodiversity loss, sea level rise). With respect to drinking water, 'hazard' can be understood as a microbiological, chemical, physical or radiological agent that causes harm to human health. Geological or geophysical hazards originate from internal earth processes (e.g. earthquakes, volcanic activity, landslides, rockslides, mud flows). Hydrometeorological hazards are of atmospheric, hydrological or oceanographic origin (e.g. cyclones, typhoons, hurricanes, floods, drought, heatwaves, cold spells, and coastal storm surges). Hydrometeorological conditions can also be a factor in other hazards such as landslides, wildland fires and epidemics. Technological hazards originate from industrial or technological conditions, dangerous procedures, infrastructure failures or specific human activities (e.g. industrial pollution, nuclear radiation, toxic waste, dam failures, transport accidents, factory explosions, fires, chemical spills).

[SOURCE: ISO 37123:2019, 3.3]

3.6
resilience
ability to absorb and adapt in a changing environment

Note 1 to entry: In the context of urban resilience the ability to absorb and adapt to a changing environment is determined by the collective capacity to anticipate, prepare and respond to threats and opportunities by each individual component of an urban system.

[SOURCE: ISO 22300:2021, 3.1.206]

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3.7
smart community infrastructure
community infrastructure (3.2) with enhanced technological performance that is designed, operated and maintained to contribute to sustainable development and *resilience* (3.6) of the *community* (3.1)

[SOURCE: ISO 37156:2020, 3.1.4]

4 Basic concept and purposes of disaster risk reduction

4.1 General

Adopted at the UN World Conference on Disaster Risk Reduction in Sendai, Japan, in 2015, the Sendai Framework for Disaster Risk Reduction (SFDRR) is an agreement that provides communities with concrete actions to protect themselves from the risk of disasters. Four priorities for actions are identified in the SFDRR:

— understanding disaster risk,

— strengthening disaster risk governance to manage disaster risk,

— investing in disaster risk reduction for resilience,

— enhancing disaster preparedness for effective response, and to “Build Back Better” a term that emerged during the SFDRR which refers to the recovery, rehabilitation and reconstruction phase.

The SFDRR identifies the need to incorporate the use of technologies that can collect information and assist in disaster risk governance at various disaster phases. “In order to reduce disaster risk, there is a need to address existing challenges and prepare for future ones by focusing on monitoring, assessing and understanding disaster risk and sharing such information and on how it is created; strengthening disaster risk governance and coordination across relevant institutions and sectors and the full and meaningful participation of relevant stakeholders at appropriate levels; investing in the economic, social, health, cultural and educational resilience of persons, communities and countries and the environment, as well as through technology and research; and enhancing multi-hazard early warning systems, preparedness, response, recovery, rehabilitation and reconstruction. To complement national action and capacity, there is a need to enhance international cooperation between developed and developing countries and between States and international organizations" (SFDRR P.11).

By investing in these technologies, the SFDRR indicates that smart community infrastructure for disaster risk reduction can lead to the reduction of casualties and damages during a disaster event strengthen the resilience of the community’s livelihoods. “Public and private investment in disaster risk prevention and reduction through structural and non-structural measures are essential to enhance the economic, social, health and cultural resilience of persons, communities, countries and their assets, as well as the environment. These can be drivers of innovation, growth and job creation. Such measures are cost-effective and instrumental to save lives, prevent and reduce losses and ensure effective recovery and rehabilitation" (SFDRR P.18).

The importance of standardization is highlighted in the SFDRR. “Strengthening, as appropriate, disaster-resilient public and private investments, particularly through structural, non-structural and functional disaster risk prevention and reduction measures in critical facilities, in particular schools and hospitals and physical infrastructures; building better from the start to withstand hazards through proper design and construction, including the use of the principles of universal design and the standardization of building materials; retrofitting and rebuilding; nurturing a culture of maintenance; and taking into account economic, social, structural, technological and environmental impact assessments" (SFDRR P.19). “Promoting the further development and dissemination of instruments, such as standards, codes, operational guides and other guidance instruments, to support coordinated action in disaster preparedness and response and facilitate information sharing on lessons learned and best practices for policy practice and post-disaster reconstruction programmes" (SFDRR P.22).

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Through the creation of standards, this document hopes to disseminate information on global best practices which can lead to the sharing and exchange of information between communities and countries. “Promoting the further development of and investment in effective, nationally compatible, regional multi-hazard early warning mechanisms, where relevant, in line with the Global Framework for Climate Services, and facilitate the sharing and exchange of information across all countries (SFDRR P.22). Promoting cooperation between academic, scientific and research entities and networks and the private sector to develop new products and services to help to reduce disaster risk, in particular those that would assist developing countries and their specific challenges (SFDRR P.20), and to disseminate and share good practices internationally" (SFDRR P.16).

In order to guide the survey to identify global best practices in regard to smart community infrastructure for disaster risk reduction, this document identifies key themes identified within the SFDRR.

4.2 Disaster risk reduction planning

Disasters have demonstrated that the recovery, rehabilitation and reconstruction phase, which needs to be prepared ahead of a disaster, is a critical opportunity to “Build Back Better”, including through integrating disaster risk reduction into development measures, making nations and communities resilient to disasters (SFDRR P.21). However, addressing underlying disaster risk factors through disaster risk-informed public and private investments is more cost-effective than primary reliance on post-disaster response and recovery, and contributes to sustainable development (SFDRR P.13). To encourage the establishment of necessary mechanisms and incentives to ensure high levels of compliance with the existing safety-enhancing provisions of sectoral laws and regulations, including those addressing land use and urban planning, building codes, environmental and resource management and health and safety standards, and update them, where needed, to ensure an adequate focus on disaster risk management (SFDRR P.17). To apply risk information in all its dimensions of vulnerability, capacity and exposure of persons, communities, countries and assets, as well as hazard characteristics, to develop and implement disaster risk reduction policies (SFDRR P.15).

4.3 Disaster research

Promoting investments in innovation and technology development in long-term, multi-hazard and solution-driven research in disaster risk management to address gaps, obstacles, interdependencies and social, economic, educational and environmental challenges and disaster risks (SFDRR P.15).

Enhancing the development and dissemination of science-based methodologies and tools to record and share disaster losses and relevant disaggregated data and statistics, as well as to strengthen disaster risk modelling, assessment, mapping, monitoring and multi-hazard early warning systems (SFDRR P.16).

4.4 Safer infrastructure

Strengthening, as appropriate, disaster-resilient public and private investments, particularly through structural, non-structural and functional disaster risk prevention and reduction measures in critical facilities, in particular schools and hospitals and physical infrastructures; building better from the start to withstand hazards through proper design and construction, including the use of the principles of universal design and the standardization of building materials; retrofitting and rebuilding; nurturing a culture of maintenance; and taking into account economic, social, structural, technological and environmental impact assessments (SFDRR P.19).

4.5 Human resource development

Building the knowledge of government officials at all levels, civil society, communities and volunteers, as well as the private sector, through sharing experiences, lessons learned, good practices and training and education on disaster risk reduction, including the use of existing training and education mechanisms and peer learning (SFDRR P.15).

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Training the existing workforce and voluntary workers in disaster response and strengthen technical and logistical capacities to ensure better response in emergencies (SFDRR P.21).

4.6 Stockpiling

Establishing community centres for the promotion of public awareness and the stockpiling of necessary materials to implement rescue and relief activities (SFDRR P.21).

4.7 Securing evacuation support

Strengthening the capacity of local authorities to evacuate persons living in disaster-prone areas (SFDRR P.22).

4.8 Securing evacuation facilities

Promoting regular disaster preparedness, response and recovery exercises, including evacuation drills, training and the establishment of area-based support systems, with a view to ensuring rapid and effective response to disasters and related displacement, including access to safe shelter, essential food and non-food relief supplies, as appropriate to local needs (SFDRR P.21).

4.9 Procurement and supply of goods

Increasing business resilience and protection of livelihoods and productive assets throughout the supply chains, ensure continuity of services and integrate disaster risk management into business models and practices (SFDRR P.20).

4.10 Rescue, emergency and firefighting

Establishing community centres for the promotion of public awareness and the stockpiling of necessary materials to implement rescue and relief activities; To adopt public policies and actions that support the role of public service workers to establish or strengthen coordination and funding mechanisms and procedures for relief assistance and plan and prepare for post-disaster recovery and reconstruction; To train the existing workforce and voluntary workers in disaster response and strengthen technical and logistical capacities to ensure better response in emergencies (SFDRR P.21).

4.11 Medical activities

Enhancing the resilience of national health systems, including by integrating disaster risk management into primary, secondary and tertiary health care, especially at the local level; developing the capacity of health workers in understanding disaster risk and applying and implementing disaster risk reduction approaches in health work; promoting and enhancing the training capacities in the field of disaster medicine; and supporting and training community health groups in disaster risk reduction approaches in health programmes, in collaboration with other sectors, as well as in the implementation of the International Health Regulations (2005) of the World Health Organization (SFDRR P.19).

4.12 Health (physical and mental)

Enhancing cooperation between health authorities and other relevant stakeholders to strengthen country capacity for disaster risk management for health, the implementation of the International Health Regulations (2005) of the World Health Organization and the building of resilient health systems (SFDRR P.20).

Enhancing recovery schemes to provide psychosocial support and mental health services for all people in need (SFDRR P.22).

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4.13 Voluntary support

Training the existing workforce and voluntary workers in disaster response and strengthen technical and logistical capacities to ensure better response in emergencies (SFDRR P.21).

4.14 Epidemic prevention

Establishing a mechanism of case registry and a database of mortality caused by disaster in order to improve the prevention of morbidity and mortality (SFDRR P.22). To promote transboundary cooperation to enable policy and planning for the implementation of ecosystem-based approaches with regard to shared resources, such as within river basins and along coastlines, to build resilience and reduce disaster risk, including epidemic and displacement risk (SFDRR P.18).

4.15 Securing transportation routes

Promoting the resilience of new and existing critical infrastructure, including water, transportation and telecommunications infrastructure, educational facilities, hospitals and other health facilities, to ensure that they remain safe, effective and operational during and after disasters in order to provide live-saving and essential services (SFDRR P.21).

4.16 Securing communication means and lifelines

Investing in, develop, maintain and strengthen people-centred multi-hazard, multisectoral forecasting and early warning systems, disaster risk and emergency communications mechanisms, social technologies and hazard-monitoring telecommunications systems; develop such systems through a participatory process; tailor them to the needs of users, including social and cultural requirements, in particular gender; promote the application of simple and low-cost early warning equipment and facilities; and broaden release channels for natural disaster early warning information (SFDRR P.21).

4.17 Livelihood recovery

Increasing business resilience and protection of livelihoods and productive assets throughout the supply chains, ensure continuity of services and integrate disaster risk management into business models and practices (SFDRR P.20).

4.18 Recovery planning

Promoting the incorporation of disaster risk management into post-disaster recovery and rehabilitation processes, facilitate the link between relief, rehabilitation and development, use opportunities during the recovery phase to develop capacities that reduce disaster risk in the short, medium and long term, including through the development of measures such as land-use planning, structural standards improvement and the sharing of expertise, knowledge, post-disaster reviews and lessons learned and integrate post-disaster reconstruction into the economic and social sustainable development of affected areas. It is advisable that this also applies to temporary settlements for persons displaced by disasters (SFDRR P.22).

4.19 Recovery action

Addressing underlying disaster risk factors through disaster risk-informed public and private investments is more cost-effective than primary reliance on post-disaster response and recovery, and contributes to sustainable development (SFDRR P.13).

Ensuring the continuity of operations and planning, including social and economic recovery, and the provision of basic services in the post-disaster phase (SFDRR P.21).

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4.20 Collection and transmission of observation data

Promoting the collection, analysis, management and use of relevant data and practical information and ensure its dissemination, taking into account the needs of different categories of users, as appropriate (SFDRR P.14).

4.21 Collection and disseminating disaster information

Developing and periodically update and disseminate, as appropriate, location-based disaster risk information, including risk maps, to decision makers, the general public and communities at risk of exposure to disaster in an appropriate format by using, as applicable, geospatial information technology (SFDRR P.15).

Promoting real time access to reliable data, make use of space and in situ information, including geographic information systems (GIS), and use ICT innovations to enhance measurement tools and the collection, analysis and dissemination of data (SFDRR P.15).

5 Existing practices and documents relevant to disaster risk reduction

5.1 General

This clause gives an overview of existing concepts and initiatives relevant to disaster risk reduction. Due to common risks to natural hazards occurring globally, the standardization for disaster risk reduction in smart community infrastructure can help communities better anticipate and prepare for hazard events and reduce vulnerabilities. Subclause 5.2 examines what has been published thus far in international documents, on disaster risk reduction. As many international organizations such as the United Nations and World Economic Forum, have published documents in the English language, the document review is limited to publications produced in English. However, in some cases, national level documents that were published in English are also considered. Subclause 5.3 describes the survey design developed by this document which was used to acquire information on current and planned implementation of smart community infrastructure for disaster risk reduction. Subclause 5.4 analyses the survey results and compares it with the results of the document search as well as how these examples meet the key themes in disaster risk reduction as outlined in Clause 4. Subclause 5.5 is an issue landscape which categorizes the key themes identified in the Basic Concept in Disaster Risk Reduction in Clause 4 and aligns them with existing publications developed by the United Nations, national governments, and with other ISO deliverables. Finally, 5.6 provides a solution landscape, which utilizes the examples provided by the survey and categorizes them in terms of how they can be used by disaster phase and hazard type.

5.2 Literature review — Document search

431 documents in the English language were analysed. This included 230 documents published by the United Nations Office for Disaster Risk Reduction, 104 documents and presentations presented at the 2017 and 2019 World Bosai Forum, 49 documents published by the US National Institute of Standards and Technology, 18 documents published by the Global Facility for Disaster Reduction and Recovery, 15 documents published by United Nations Economic and Social Commission for Asia and the Pacific, 10 documents published by the International Recovery Platform, and 1 document each published by Elsevier, the Japanese Ministry of Land, Infrastructure, Transport and Tourism (MLIT), the World Economic Forum, the International Federation of Red Cross and Red Crescent Societies, and the Association of Pacific Rim Universities and Tohoku University's APRU-IRIDeS Program. Out of the 431 documents researched, 243 relevant items were identified. Tables 1 and 2 summarize the results of this document search into key areas. First by region, based on the categorization by the UNDRR which includes the Asia and Pacific, Europe, Americas and the Caribbean, Arab States, Africa, and examples that were applied globally rather than by a specific region. Second, the results were categorized by infrastructure type concentrating on transportation, energy, waste and water, ICT, food security, and the built environment (e.g. hospitals, schools, homes, offices), food security, which refer to infrastructure that does not fall within the aforementioned categories. Disaster phases were categorized into three groups: the prevention and preparedness phases which occur prior to a disaster event, the response

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phase which occurs immediately after the event, and Build Back Better, which the SFDRR refers to as the recovery and reconstruction phases that follows the response phase. Finally, the items are also broken down by hazard types that are caused either by hydrometeorological or geological events.

Table 1 — Region and infrastructure type from the document search

Region	Items	Percentage
Asia and Pacific	96	40 %
Europe	29	12 %
Americas and the Caribbean	56	23 %
Arab States	18	7 %
Africa	17	7 %
Global	27	11 %
Total	243	

Infrastructure type	Items	Percentage
Transportation	18	7 %
Energy	14	6 %
Waste and Water	30	12 %
ICT/ Communication	110	45 %
Built Environment	49	20 %
Food Security	6	2 %
Others	18	7 %
Total	245	

NOTE If an item spans multiple regions or infrastructure types, it is counted multiple times.

Table 2 — Hazard type and disaster phase from the document search

Hazard type	Items	Percentage
Flood	72	21 %
Earthquake	45	13 %
Tropical Cyclone	40	12 %
Heavy Rain	40	12 %
Drought	17	5 %
Tsunami	16	5 %
Wildfire	11	3 %
Volcanic Activity	11	3 %
Landslide	7	2 %
Tornado	6	1 %
Heatwave	4	1 %
General	72	22 %
Other (e.g. coastal erosion)	3	1 %
Total	344	

Disaster phase type	Items	Percentage
Prevention and Preparedness	151	57 %
Response	37	14 %
Build Back Better	30	11 %
General	49	18 %
Total	267	

NOTE If an item spans multiple hazard types or disaster phases types, it is counted multiple times.

An analysis of the document search revealed that nearly two-thirds of the literature focused on the Asia and Pacific Region and the Americas and Caribbean Region. This can be explained by the proximity of the western coast of the Americas, and the Asia and Pacific Region to the Ring of Fire, a region known for significant geological activity, such as earthquakes and volcanoes which can generate powerful tsunamis. Additionally, the Asia and Pacific Region and the eastern coastline of the Americas and the Caribbean experience significant hydrometeorological activity which leads to tropical cyclones and heavy rain. Europe is the third most commonly mentioned area behind the Asia and Pacific and Americas and Caribbean Regions. European communities are exposed to hazard risks caused by flooding due to the presence of multiple large rivers, while the communities around the Mediterranean and Caucasus are vulnerable to geological risks due to seismic activity in the region. The document search revealed that Arab States and Africa came in roughly equally with 7 % of the results. Although these two regions were not often cited in the document search, issues with droughts, heatwaves, flooding and earthquakes are frequent in these two regions. 11 % of the items discovered in the literature review focused on more general disaster-related infrastructure that can be referred to more globally.

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In regard to the breakdown of infrastructure type, nearly half of the items focused on the role ICT plays in disaster risk reduction. This reflects the importance ICT infrastructure plays in the collection and dissemination of data to community stakeholders, which can be utilized at various disaster phases and strengthen resiliency. At 20 %, the next most common infrastructure focused on the built environment, which includes homes, buildings, and other facilities. Aspects of the built environment, such as their design and construction, location, and use cases can influence the survivability of the community and its economy. Waste and water were the next key infrastructure listed with 12 %, which includes sewer systems, ponds and other forms of water management, waste such as garbage, and wastewater infrastructure, which deals with water that has been contaminated by human activity, surface runoff, or stormwater. Transportation infrastructure was listed at 7 % of the review items, as maintaining accessibility serves a critical function in resiliency. Energy infrastructure was listed at 6 %, which focused on the resiliency of the facilities such as power plants, energy grids, and other energy-producing and managing facilities whose continued operation is vital for the community. Food security had the fewest comments at 2 %, despite the key role it plays during the recovery and Build Back Better process.

In terms of hazard types, general multi-hazard related literature comprised 22 % of the total documents, or nearly one-quarter of all literature research. However, in terms of specific hazards, floods were the most common, comprising 21 % of the results, followed by earthquakes at 13 % and tropical storms, which include typhoons, hurricanes, and cyclones, and heavy rain came at 12 %. Droughts and tsunamis came at 5 %, highlighting that although tsunamis are generated by seismic activities such as earthquakes, not all earthquakes necessarily lead to the creation of tsunamis. Wildfires and volcanic activities consisted of 3 % of the results, and landslides at 2 %. The remaining hazards such as tornadoes, heatwaves, and other hazards such as coastal erosion, came in at 1 %.

The distribution of responses by disaster phases resulted in more than half of the literature focused on the prevention and preparedness phase at 57 %. This reflects one of the SFDRR's guiding principles in which addressing underlying disaster risk factors are more cost-effective than primary reliance on post-disaster response and recovery. General phases (those that did not address a specific disaster phase or were broadly applied to all phases) were the next most common at 18 %, followed by the response phase at 14 % and Build Back Better at 11 %.

5.3 Survey design

The basis of the survey design is a document search which was conducted in order to provide background information on existing publications on smart community infrastructure for disaster risk reduction. The results of this document search identify past and current global initiatives and activities in disaster risk reduction that have been published in international literature. Based upon the themes identified in the SFDRR, this document then utilizes a survey to identify specific examples of current or planned smart community infrastructure for disaster risk reduction that exists globally.

The 16-question survey was designed to gather information on the current or planned implementation of smart community infrastructure that contributes to disaster resiliency globally. The questions can be divided into three areas: background information, functions based on the twenty themes identified in Clause 4, and detailed explanations.

The questions were broken down as follows:

— Questions one through three: ask respondents to provide background information that can identify the infrastructure and technology being examined, such as the name or title of the infrastructure and technology, its location, and the developer and operator of this infrastructure and technology.

— Questions four through nine: seek to examine the specific functions of the infrastructure and technology in question. These include identifying the hazard type being addressed, infrastructure type and disaster phase(s) that the infrastructure is oriented towards. These categories of infrastructure are based on those identified in existing International Standards used in ISO TC 268 as well as other ISO Technical Committees, such as ISO TC 224. Disaster phases are based on those identified by documents by the United Nations, in particular the post-disaster phase utilizes the term 'Build Back Better' which was adopted by the SFDRR, in reference towards the need to re-think

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