PANTHEON

Community-Based Smart City Digital Twin Platform for Optimised DRM operations and Enhanced Community Disaster Resilience

D9.2

REPORT ON STANDARDS, SYNERGIES AND CRISIS MANAGEMENT / CBRN-E

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TASK ABSTRACT

The present Deliverable is a report on the activities relevant to the T9.2 “Standardization activities and collaboration with existing initiatives”. The aim of the Task is to engage the PANTHEON research project into ongoing standardisation activities, which can potentially cover a wide range of aspects, from technical to procedural, in terms of disaster management stakeholders’ operational procedures.

[1] **Please indicate the type of the deliverable using one of the following codes**:
R = Document, report
DEM = Demonstrator, pilot, prototype, plan designs
DEC = Websites, patents filing, press & media actions, videos
DATA = data sets, microdata
DMP = Data Management Plan
ETHICS: Deliverables related to ethics issues.
OTHER: Software, technical diagram, algorithms, models, etc.

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LIST OF ABBREVIATIONS

Abbreviation	Meaning
AI	Artificial Intelligence
AR	Augmented Reality
CEN	Comité Européen de Normalisation (European Committee for Standardisation)
CIM	City Information Modelling
CLC	The European Committee for Electrotechnical Standardization
CM	Crisis Management
CWA	CEN Workshop Agreement
Dx.y	Deliverable x.y
DoA	Description of Actions
DRM	Disaster Risk Management
DT	Digital Twin
EC	The European Commission
EFTA	European Free Trade Association
EG	ETSI Guide
ELOT	The Hellenic Organisation for Standardisation
EN	European Norm
ES	ETSI Standard
ETSI	The European Telecommunications Standards Insitute
EU	The European Union
GIS	Geographic Information Systems
GR	Group Report
GS	Group Specification
H2020	The Horizon 2020 funding programme
HEU	The Horizon Europe funding programme
HS Booster	Horizon Standardisation Booster
ICT	Information Communication Technologies
IEC	The International Electrotechnical Committee
IEEE	The Institute of Electrical and Electronics Engineers
IFRC	The International Federation of Red Cross and Red Crescent Societies
IHU	International Hellenic University
IoT	Internet of Things
ISO	International Organisation for Standardization
ITU	The International Telecommunication Union
ITU-T	ITU Telecommunication Sector
JTC	Joint Technical Committee
JWG	Joint Working Group
KPI	Key Performance Indicator
MHIM	Multi-Hazard Impact Methodology
MR	Mixed Reality
NATO	The North Atlantic Treaty Organization
NGO	Non-Governmental Organisation
NSB	National Standardisation Body
NSO	NATO Standardization Office

NWIP	New Working Item Proposal
OGC	The Open Geospatial Consortium
SB	Standardisation Body
SC	Smart Cities
SCDT	Smart City Digital Twin
SG	Study Group
SotA	State of the Art
SR	Special Report
Tx.y	Task x.y
TB	Technical Body
TC	Technical Committee
TR	Technical Report
TS	Technical Specification
UDT	Urban Digital Twin
UN	The United Nations
VCA	Vulnerability and Capacity Assessment
VR	Virtual Reality
WG	Working Group
WHO	The World Health Organization
WMO	The World Meteorological Organization
WPx	Work Package x
WTO	The World Trade Organisation
XR	Extended Reality

EXECUTIVE SUMMARY

Disasters are increasing not only in frequency but also in severity and complexity. Climate change is a significant factor, which further exacerbates the impact of disasters in modern life. Furthermore, man-made hazards, spanning from technological accidents to malicious attacks and warfare, increase threats to lives, livelihoods, infrastructures, the economy and the environment. Vulnerability is another factor that plays an important role and includes, among others, societal vulnerability, geo-political instability, ageing infrastructures, high level of interconnectedness between critical entities, low level of community engagement in crisis management (CM) and lack of interoperability between crisis management stakeholders.

Standardisation could be the key in creating a well organised and coordinated defence mechanism against the various disasters that threaten modern societies. It is through standardisation that interoperability, a crucial aspect in disaster risk management (DRM), can be achieved, both in terms of technical interconnectivity and operational alignment. The former enables and facilitates the exchange of data and information between different technological systems such as software and hardware, whereas the latter can provide a "common language" for CM practitioners, something crucial especially in cases when disasters simultaneously affect different countries and require cross-organisation and cross-border cooperation.

PANTHEON may not be directly linked to standardisation activities, however research conducted within the context of the project, the technical achievements and developments over the past 2.5 years of implementation and, more importantly, the societal involvement in DRM, which is one of the core aspects of the project, have produced significant results and can potentially feed the standardisation community by either triggering new standardisation working items or providing inputs to standards under development or under revision.

T9.2 "Standardization activities and collaboration with existing initiatives" and the respective D9.2 "Report on standards, synergies and Crisis Management / CBRN-E" entail the collaboration and potential involvement of PANTHEON in ongoing standardisation. The various activities that took place under the framework of this task are presented in detail in the current deliverable, as they are the outcomes of discussions between the project and the Standardisation Bodies (SBs), with the utter aim of exploring possible synergies and integration of the PANTHEON research outcomes into current or even future projects that the Technical Committees (TCs) of the aforementioned SBs will initiate. It is noteworthy, that these discussions will continue even after the submission of the present Deliverable, whereas collaboration might last well beyond the termination of PANTHEON, significantly adding visibility for the project and providing the opportunity to exploit its results.

1. INTRODUCTION

The objective of this deliverable is to provide a full report on standardisation-related activities that took place already from the initiation of PANTHEON, as T9.2 spans across the 36 months project duration. The initial focus of the Task was on the contribution of the project to a specific standard developed under the umbrella of the International Organisation for Standardization (ISO), the ISO/DIS 22361:2022 "Security and resilience – Crisis management – Guidelines" standard. According to the Description of Actions (DoA) of the task, the intention was to actively participate in the, at that time under development, standardisation document and implement activities accordingly. However, by the time the project was initiated, this standard was already finalised and published, therefore no changes or suggestions could be made and adopted, except only in the case of revision of the standard. This situation led to a reconsideration with regards to how the project could actually participate in the field of standardisation. Although this differentiation resulted in an initial confusion, as there was no distinct path to follow, it provided a relative freedom to task participants and the Consortium overall, to explore various aspects related to the civil protection and disaster management domains, reach a consensus with regards to the most interesting areas and come in contact with the respective SBs and committees.

A first-class opportunity to spark standardisation-related discussions was presented through the Horizon Standardisation Booster (HS Booster) programme, an initiative of the European Commission (EC), that provides expert advice and assistance to EU research projects in order to build on their results and valorise them through cooperation and engagement in standardisation activities. The HS Booster programme, during its 36-month duration, organised numerous open calls for experts, during which research projects could apply and ask for guidance from the assigned experts of the programme. PANTHEON took advantage of this opportunity in order to make a first step towards its involvement in standardisation. The process for applying to the HS open calls, the exchange of ideas with HS experts and the outcomes from the participation in this programme are described in detail in the present Deliverable.

Overall, this Deliverable is structured upon four main pillars:

1. An introduction to the world of standardisation including, inter alia, a presentation and brief description of SBs, TCs and respective Working Groups (WGs) with the aim of creating a map of the current DRM-related standardisation domain,
2. A detailed description of the work that has been carried out under the framework of collaboration and exchange of ideas between PANTHEON and HS Booster.
3. The direct communications and discussions with SBs and the conveners of relevant WGs and TCs, building on the significant support from HS Booster, with the aim of presenting PANTHEON and its core outcomes, and exploring whether there is interest from the SB representatives and how can PANTHEON fit in and integrate its results.
4. Description of the PANTHEON recommendations to SBs and the EC in order to shape future DRM-related standardisation directions.

It has to be noted that standardisation procedures are lengthy, often exceeding the lifetime of a project, however a successful engagement of PANTHEON in standardisation will ensure a long lasting and strong visibility within the research and standardisation domains, whereas its results will provide recommendations that will trigger future research.

2. THE STANDARDISATION LANDSCAPE

Standards are documents that can be considered as guidelines on how to do something and are based on the consensus between interested parties which participate in their development. The European Committee for Standardisation (CEN) provides a clear definition of what a standard is describing it "*as a document, established by consensus and approved by a recognized body that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context. Standards should be based on consolidated results of science, technology and experience, and aimed at the promotion of optimum community benefits*" (CEN/CLC, 2025). Standards can have a significant impact on and benefit their direct users, especially when considering the fragmentation which significantly affects contemporary market and labour. As they practically comprise the outcomes of collaboration and exchange of knowledge and ideas between experts in a specific matter, they can be considered as recommendations for other users to develop items (technological innovations, products, services and protocols) of high quality. Regarding the users of standards, Woitsch et al. (2020) mention the following benefits brought by standardisation:

- Standards enable users' access to the latest scientific knowledge and competence, as they are produced by experts on a specific domain,
- Standards pave the way for the unification and free movement of goods and services,
- They create easily comparable and verifiable results, limiting discrepancies,
- When correctly applied during the stage of development, they ensure the high quality of products and services,
- They facilitate interoperability and compatibility of different products and services.

2.1 GEOGRAPHICAL DIMENSION OF STANDARDISATION

There are three geographical levels in standardisation i.e., the national, the EU-wide and the international level. Each country, either within or outside the EU, has a National Standardisation Body (NSB) that comprises of several committees. Each of these committees is composed of various stakeholders' representatives. Stakeholders may derive from the industry, research and academia, non-governmental organisations (NGOs) and other domains. Together they draft national standards. NSBs are also members of the European and International Standardisation Bodies providing feedback and input for the development of EU-wide and international standards. More specifically, for a named area of interest, there are TCs in international and EU SBs, which are mirrored in committees of NSBs. For instance, regarding the topic of fire protection, the relevant committee of the Hellenic Organisation for Standardisation (ELOT) is the TC 7 "Fire protection and Firefighting". Representatives of the ELOT TC 7 are members of the CEN TC 127 "Fire safety in buildings", CEN TC 191 "Fixed firefighting systems", CEN TC 192 "Fire service equipment" and CEN TC 72 "Fire detection and fire alarm systems", at the European level, and of the ISO TC 21 "Equipment for fire protection and firefighting" and ISO TC 92 "Fire safety" at the international level. Similarly, regarding crisis management, at the national level there is the ELOT TC 104 "Protection against emergency threats and risk management", which, at the EU level, corresponds to CEN TC 391 "Societal and citizen security" and, at the international level, is mirrored by the ISO TC 292 "Security and resilience". Finally, within a TC, one or several Working Groups (WGs) exist, each responsible for the development of specific sets of standards.

In the EU there are three main Standardisation Bodies:

1. The European Committee for Standardisation (CEN). CEN consists of representatives from 34 NSBs and develops various standardisation documents e.g., CEN Workshop Agreements (CWAs), Technical Specifications (TSs), Technical Reports (TRs) and European Norms (ENs). More than 200,000 experts are involved in the network of CEN and CENELEC. During 2024, 1073 standardisation deliverables had been developed, while, as of the end of December 2024, a total number of 18741 standards had been developed by the 2263 active Technical Bodies (TBs) of the organisation (CEN/CLC, 2025).
2. The European Committee for Electrotechnical Standardisation (CENELEC). CENELEC, similarly to CEN consists of members from 34 NSBs, including 27 from the EU countries along with the inclusion of the UK, the Republic of Northern Macedonia, Serbia and Turkey as well as three countries of the European Free Trade Association (EFTA) i.e., Switzerland, Norway and Iceland (CEN/CLC, 2025).
3. The European Telecommunications Standards Insitute (ETSI). Although it is a European Standardisation Body, ETSI involves more than 900 member organisations coming from 60 different countries. It consists of 29 TCs, 15 industry specification groups and four software development groups. ETSI develops different types of standardisation deliverables including ENs, ETSI Standards (ESs), ETSI Guides (EGs), Technical Specifications (TSs), Technical Reports (TRs), Special Reports (SRs), Group Specifications (GSs) and Group Reports (GRs) (ETSI Standards, 2025).

The aforementioned Bodies consist of Technical Committees (TCs), each responsible for the development of standardisation documents in specific topics. The TCs are composed of representatives from the respective committees of the NSBs, who express the opinions of the national committees.

Proceeding to the international level, the main SBs are the following four:

1. The International Organisation for Standardisation (ISO). ISO involves 174 member countries, 824 TCs and has developed 25862 standards covering the whole spectrum of technology, management and manufacturing related aspects. It is noteworthy that all CEN members are concurrently ISO members as well (ISO, 2025).
2. The International Electrotechnical Committee (IEC). IEC brings together 170 countries with 30,000 experts. Approximately 10,000 standards have been published by IEC. Overall, 229 TCs comprise the IEC, with 26 being Joint Technical Committees (JTCs) of both IEC and ISO (IEC, 2025).
3. The International Telecommunication Union (ITU). ITU specialises in the development of standards relevant to information and communication technologies (ICTs) and is a United Nations (UN) agency. The Telecommunication Standardization Sector of ITU (ITU-T) comprises of currently 10 different Study Groups (SGs) that develop standards known as ITU-T Recommendations and form the basis of the work programme for the 2025-2028 period (ITU, 2025).
4. The Institute of Electrical and Electronics Engineers (IEEE). IEEE consists of 486,000 members from 190 member countries and includes 39 technical societies. As of today, 1,079 standards have been developed by the IEEE, whereas another 1,093 documents are currently under development (IEEE, 2025).

Similarly to the EU SBs, the international Bodies compose of TCs, each responsible for the development of standards in a specific topic. As described above, for each topic committees are formed at the national level and are mirrored at the EU and the international level.

Apart from the official SBs, there are other organisations responsible for the development of standards, which, although not officially recognised by NSBs and governments, are fully accepted by various sectors and implemented accordingly, as explained by Woitsch et al. (2020). Military standards developed by the NATO

Standardization Office (NSO) are a characteristic example of standards used extensively by the military forces of the North Atlantic Treaty Organization (NATO) member countries. The Open Geospatial Consortium (OGC) is another example of a volunteering association, comprising of approximately 450 organisations, that develops standards relevant to geospatial data and Geographic Information Systems (GIS). The World Meteorological Organization and the World Health Organization are other instances of non-Standardisation Bodies, which develop documents of wide acceptance within the relevant fields of expertise and can be considered as standards although they are not in the strict sense of the term.

2.2 PRINCIPLES OF STANDARDISATION

The development of standardisation documents relies on six basic principles, developed by the World Trade Organisation (WTO), which act as guarantees of the high quality of standards and are valid for all three geographical levels (national, EU and international) (Woitsch et al., 2020). These principles include:

- ***Transparency:*** All information about ongoing standardisation activities, suggestions for future standardisation as well as the results and outcomes of a recently developed or revised standard should be easily accessible by all interested parties.
- ***Openness:*** All members of a TC, either from an EU or international SB, should be free to participate in each step of the standardisation process.
- ***Impartiality and consensus:*** A standard is the outcome of a joint effort among the members participating in the development process. The process should not favour one member against another and consensus amongst the interested parties should be established already from the beginning in order to resolve potential conflicts.
- ***Effectiveness and relevance:*** Market needs should be considered as well as scientific findings and technological developments, when initiating the process for the development of a new standard, with the same also applying to legal issues and consumer concerns. Outdated and obsolete standards should be reviewed for their relevance and withdrawn if ineffective and inappropriate.
- ***Coherence:*** Standards should be coherent and not contradict each other, something that can be achieved through coordination and communication among the various TCs of a SB.
- ***Development dimension:*** This principle is linked to the developing countries, their limited capacity to actively participate in standardisation processes and the implementation of measures to assist them

2.3 STANDARDISATION IN CRISIS MANAGEMENT

Disasters are increasing in frequency, severity and complexity, limiting the level of safety and security. Climate change is a crucial driver that affects and shapes the nature of contemporary crises and emergencies. Interdependencies in infrastructures and critical entities are another factor that increases vulnerability, as disasters, when occurring, can have domino effects and greatly impact modern societies. Crisis management requires a multifaceted approach, as stakeholders with very different expertise, spanning from research to the industrial and operational domains, are required to cooperate and develop the appropriate tools to deal with the various natural and anthropogenic hazards. These tools can be anything, from technological innovations, in the form of software, hardware and equipment, to protocols and processes. In order these developments to be accomplished, the obstacles of different backgrounds, operational procedures and technologies used had to be overcome and that is exactly why standardisation is of utmost importance. As described in the previous subchapters, standardisation is the means for stakeholders to discuss, exchange

opinions and develop items of common acceptance and high quality, which can be broadly used to solve the problem of fragmentation both in terms of technologies and of procedures.

Building upon the above, SBs at all levels have created TCs relevant to safety and security, including CM. Furthermore, other TCs, although at first glance not relevant to disaster management, might develop documents that can be indirectly linked to this field. In the following tables, an attempt to map TCs and indicative standards, directly or indirectly related to CM, is undertaken. This mapping includes TCs only of EU and international Standardisation Bodies, not NSBs.

2.3.1 CRISIS MANAGEMENT – RELATED STANDARDISATION IN THE EU

As already described, at the EU level there are three main Bodies, which develop standards, CEN, CLC and ETSI. TCs can either fall under the umbrella of one Standardisation Body, however Joint Committees (JTCs) exist bringing together members from at least two different bodies.

According to Sakkas et al., 2020 and Woitsch et al., 2020, CEN includes at least 27 TCs, which are directly or indirectly correlated with CM and develop relevant standards as depicted in Table 1:

Table 1: CEN TCs relevant to CM

CEN TC	Title of TC
33	Doors, windows, shutters, building hardware and curtain walling
70	Manual means of fire-fighting equipment
79	Respiratory protective devices
122	Ergonomics
127	Fire safety in buildings
129	Glass in building
137	Assessment of workplace exposure to chemical and biological agents
162	Protective clothing including hand and arm protection and lifejackets
164	Water Supply
183	Waste management
191	Fixed firefighting systems
192	Fire and rescue service equipment
224	Personal identification and related personal devices with secure elements, systems, operations and privacy in a multi sectorial environment
234	Gas Infrastructure
239	Rescue systems
250	Structural Eurocodes
251	Healthcare informatics
263	Secure storage of cash, valuables and data media
278	Intelligent transport systems
340	Anti-seismic devices
346	Conservation of cultural heritage
352	Nanotechnologies
391	Societal and citizen security

430	Nuclear energy, nuclear technologies, and radiological protection
439	Private security services

The most prominent TC related to CM is the CEN/TC 391 “Societal and citizen security”. Proceeding to CENELEC, there are 10 TCs relevant to CM, which are depicted in Table 2.

Table 2: CLC TCs relevant to CM.

CLC TC	Title of TC
CLC/WS NEST	Open protocol for CBRN sensor connectivity
TC 216	Gas detectors
SR 124	Wearable Electronic Devices and Technologies
TC 111X	Environment
SR 89	Fire hazard testing
TC 81X	Lightning protection
TC 79	Alarm systems
TC 76	Optical radiation safety and laser equipment
TC 45B	Radiation protection instrumentation
BTTF 157-1	Public address and general emergency alarm systems

Finally, there are two JTCs of CEN and CENELEC, which can be considered relevant to CM:

a) The CEN/CLC/JTC 4 “Services for fire safety and security systems” and
b) The CEN/CLC/JTC 13 “Cyber security and data protection”
c) The CEN/CLC/JTC 21 “Artificial Intelligence”

On the other hand, ETSI is a body that mainly targets the development of standards on telecommunications. Although initially not directly related to CM, telecommunications play a significant role in this domain and facilitate the exchange of data and information between operational organisations, when they are deployed in the field for the management of emergencies. To that end, a specific TC has been created, the “Emergency Communications (EMTEL)” TC. However, other TCs can also be considered relevant to CM and are presented in the following table:

Table 3: ETSI TCs relevant to CM.

ETSI TC	Title of TC
CYBER	Cyber Security
DATA	Data Solutions
eHEALTH	eHealth
EMTEL	Emergency Communications
SAFETY	Safety
SAI	Securing Artificial Intelligence
SES	Satellite Earth Stations & Systems
TCCE	TETRA and Critical Communications Evolution

2.3.2 INTERNATIONAL CRISIS MANAGEMENT – RELATED STANDARDISATION

The following table presents the ISO TCs which are relevant, in one way or another, to CM.

Table 4: ISO TCs relevant to CM.

ISO TC	Title of TC
TC 21	Equipment for fire protection and fire fighting
TC 85	Nuclear energy, nuclear technologies, and radiological protection
TC 94	Personal safety -- Personal protective equipment
TC 147	Water quality
TC 176	Quality management and quality assurance
TC 207	Environmental management
TC 210	Quality management and corresponding general aspects for medical devices
TC 224	Service activities relating to drinking water supply, wastewater and stormwater systems
TC 262	Risk management
TC 292	Security and resilience

ISO/TC 292 "Security and resilience" is the most appropriate committee, developing standards to tackle CM-related issues. Other TCs are indirectly correlated, developing standards which, although they do not target CM, can be considered as solutions to broader implications caused by the occurrence of a crisis.

IEC develops more technically oriented standardisation documents, therefore it cannot be considered closely related to CM. However, as technology can be an efficient means to manage disasters, it is crucial to use innovations developed on the basis of technical standards. IEC includes TCs related to the creation of standards for specific types of technologies that are widely used in disaster management among other areas of application e.g., AI, Virtual Reality (VR) / Augmented Reality (AR) / Extended Reality (XR) / Mixed Reality (MR), digital twins, Internet of Things (IoT) and smart city technologies. Technical standardisation facilitates interoperability between systems and tools and enhances situational awareness and the accomplishment of a common operational picture among stakeholders engaging to the management of emergency situations. Therefore, TCs presented in Table 5 are indirectly linked to CM.

Table 5: IEC TCs relevant to CM.

IEC TC	Title of TC
SC 31J	Classification of hazardous areas and installation requirements
TC 45	Nuclear instrumentation
SC 45B	Radiation protection instrumentation
TC 62	Medical equipment, software, and systems
SC 62A	Common aspects of medical equipment, software, and systems
SC 62B	Medical imaging equipment, software, and systems
SC 62C	Equipment for radiotherapy, nuclear medicine and radiation dosimetry

SC 62D	Particular medical equipment, software, and systems
TC 79	Alarm and electronic security systems
TC 81	Lightning protection
TC 89	Fire hazard testing
TA 21	Virtual (VR), Augmented (AR) and Mixed (MR) Reality systems and equipment
TC 124	Wearable electronic devices and technologies

Similarly to CEN and CLC, there are TCs falling under the umbrella of one specific international Standardisation Body, however JTCs do exist, in which different SBs join forces to develop standards covering common gaps and needs. A JTC of ISO and IEC, the ISO/IEC JTC 1 "Information technology" has been created with the aim to co-develop standards. The following Specific Subcommittees (SCs) can be considered relevant to CM:

a) SC6 "Telecommunications and information exchange between systems",
b) SC24 "Computer graphics, image processing and environmental data representation",
c) SC25 "Interconnection of information technology equipment",
d) SC27 "Information security, cybersecurity and privacy protection"
e) SC32 "Data management and interchange",
f) SC37 "Biometrics",
g) SC41 "Internet of Things and Digital Twin" and
h) SC42 "Artificial Intelligence"

ITU develops standards relevant to ICT in order to improve interoperability and facilitate communication. Thus, the ITU Telecommunication Sector (ITU-T) consists of various Study Groups (SGs), of which the most relevant to CM are:

a) SG5 "Environment, EMF, climate action & circular economy",
b) SG17 "Security",
c) SG20 "IoT, digital twins & smart cities"

Finally, the IEEE is also a technically oriented standardisation body and although its committees are not directly linked to CM, they can be considered interesting, as IEEE standards are developed for systems and tools widely used in CM. As CM-related IEEE TCs can be considered the following:

Table 6: IEEE TCs relevant to CM

IEEE TC
Aerial Robotics and Unmanned Aerial Vehicles
Automation in Health Care Management
Autonomous Ground Vehicles and Intelligent Transportation Systems
Robotics for Nuclear Environments
Safety, Security and Rescue Robotics
Smart Buildings
Wearable Robotics

Whereas chapter 1, serves as a generic map of the current CM-related standardisation landscape at the EU and international level, in the following chapters, the methodology followed for the involvement of PANTHEON in standardisation is described in detail. More specifically, in chapter 3, the interaction between the project and the HS Booster programme is presented, along with the outcomes and findings that emerged from this interaction, whereas in chapter 4, specific recommendations / research outcomes of the project, to be considered by the EU standardisation bodies and the EC, are included.

3. PANTHEON COLLABORATION WITH THE HS BOOSTER PROGRAMME

Getting involved in standardisation is crucial for the PANTHEON project, as through it the project will increase its visibility and will exploit and capitalise its outcomes even after the project's termination, thus providing significant added value to the overall DRS domain. Initially, as dictated by the description of T9.2 "Standardization activities and collaboration with existing initiatives", PANTHEON would focus on the ISO/DIS 22361:2022 "Security and resilience - Crisis management – Guidelines for a strategic capability" standard and on the implementation of work relevant both to the above standard and the use cases of the project.

The scope of the ISO 22361:2022 standard is to create the basic principles for an organisation to increase its crisis management capacity. Given the fact that crises become increasingly complex and have a significant and potentially long-lasting impact, it is important for any organisation to be able to manage and adapt to the changes a crisis will bring. An organisation should have the means and capacity to identify risks and assess whether or not they pose a threat to its sustainability. The standard sets four basic principles to ensure a stark crisis management capability:

a) Leadership,
b) Structures e.g., funding mechanisms, appropriate equipment and facilities and established procedures,
c) Supportive culture e.g., ethics and values
d) Competent personnel, that have the knowledge and skills to manage crises.

In order to delineate the crisis management framework, the organisation should greatly consider the above principles. Moreover, linkages with other interdependent fields such as risk and emergency management, business continuity and civil protection should not be overlooked, as they can significantly influence the crisis management capacity of the organisation (ISO, 2022).

However, the standard was published in October 2022, whereas the project was initiated in January 2023, therefore there was no room for any further additions to the document, which would be based on the work of PANTHEON. A potential opportunity could arise in the case of a revision and reopening of the standard, however by M30 of the project (June 2025) such a process was not scheduled. On the other hand, this development provided the project with a relative freedom to explore the standardisation domain and identify other potential opportunities e.g., within the working programme of various TCs or even specific standards under development or under revision. The EU HS Booster initiative was a first-class opportunity for PANTHEON to seek consultation and advice with regards to standardisation issues and enable its involvement to the standardisation domain. The following subchapters provide an overview of the HS Booster as well as a step-by-step description of the collaboration between PANTHEON and HS Booster.

3.1 OVERVIEW OF THE HS BOOSTER PROGRAMME

The aim of the Horizon Standardisation Booster initiative of the EU is to provide advice and consultation to national and EU-funded research projects with regards to standardisation spanning throughout all fields of research and innovation. Through this process, projects can increase their impact and exploit their results through contributions to ongoing standardisation activities, i.e., standards under development or revision. The scope of the programme is to facilitate projects to engage in the work of TCs, a process that usually requires resources and time that exceed the capacity of research projects.

The Programme organised five open calls for EU projects, from June 2022 until January 2024 with beneficiaries being mainly H2020 and HEU projects and no costs would burden the projects as all services were funded by the EC (Horizon Standardisation Booster, 2025). In order to apply for the HS Booster services, the beneficiary had to fill in an application form which included the following information:

- Full name of the project,
- Acronym of the project,
- GA number,
- Indication of the funding mechanism,
- Indication of open call topics,
- Project duration,
- TRL at the time of application, mainly for projects developing technological solutions,
- Organisation coordinating the project,
- Main contact, that will be responsible for communication with the HS experts,
- Project Officer name,
- Project Officer contact,
- Main contact for standardisation and
- WPs and contacts involved in standardisation if applicable

By filling in this application form, the HS Booster would acquire an initial overview of the project and appoint a standardisation expert, who would undertake the role of consultant for the applying project. Following the initial application and after the assignment of an expert to assist the project, the applicant had to complete a survey with the aim of providing specific information with regards to the project, the reason for application to HS, the scope and objectives of the project and potential standardisation bodies or TCs that had already been identified by the project. Concluding the survey, the expert had a clear understanding of the project and could provide advice accordingly in a series of dedicated online meetings with the project representatives. The survey and the application of PANTHEON are presented in Annex 1.

3.2 APPLICATION OF PANTHEON TO THE HS BOOSTER PROGRAMME

Following the aforementioned process, T9.2 leader, after discussions with the project coordinator and Task participants, proceeded with the completion of the application form. However, as an important aspect of the form is to indicate specific standardisation topics, consensus within the PANTHEON Consortium had to be reached regarding those topics that presented great interest for the project. Another crucial aspect was to indicate, to the HS Booster expert, what type of support and assistance was required. Thus, an internal survey was developed aimed at identifying the most interesting topics and defining the type of support that PANTHEON required from HS Booster. Among the available options, the PANTHEON Consortium had to select up to three open call topics, whereas regarding the type of support, multiple answers could be given. Only one person per Consortium partner voted in order to avoid duplications and get a singular answer per partner.

The following graph depicts the most interesting standardisation topics that are relevant to PANTHEON.

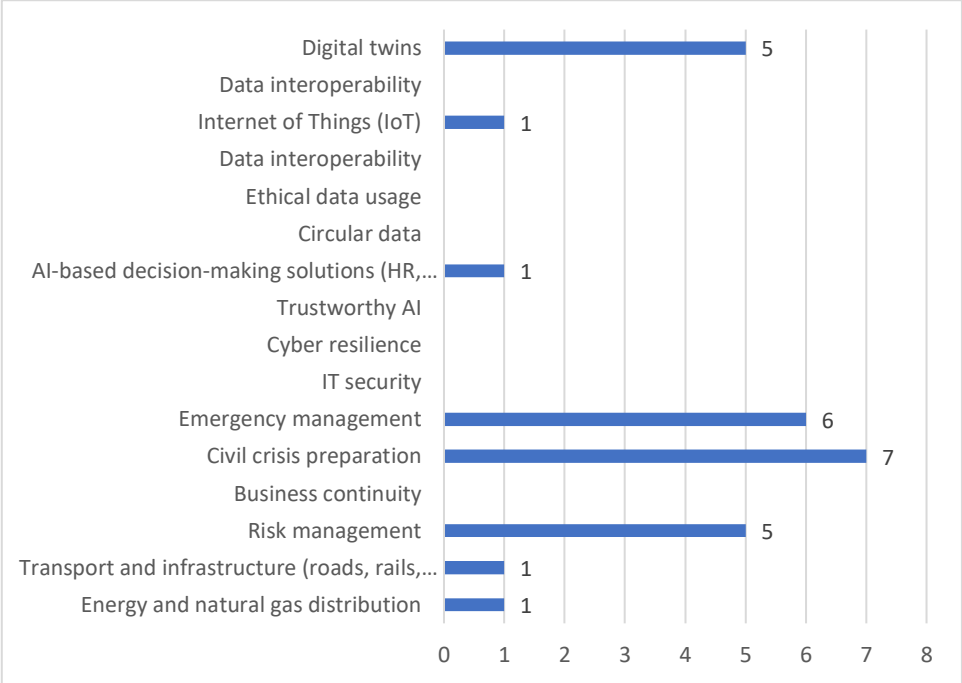

Figure 1: Number of votes per open call standardisation topics

It is apparent that "Civil crisis preparation", "Emergency management", "Risk management" and "Digital twins" were the most interesting topics according to the respondents' opinion and this comes as no surprise, considering the fact that the project aims to strengthen CM by building a community-based approach in DRM and also by developing a Smart City Digital Twin (SCDT) technology that will assist practitioners in their operations. Due to the fact that the topics "Emergency management" and "Risk management" are closely correlated and considering, furthermore, the fact that the project had to indicate a maximum of three topics, it was decided to discard "risk management" and propose to HS the "Digital twins" topic instead.

Figure 2 presents the results of the survey regarding the type of support that PANTHEON required from HS.

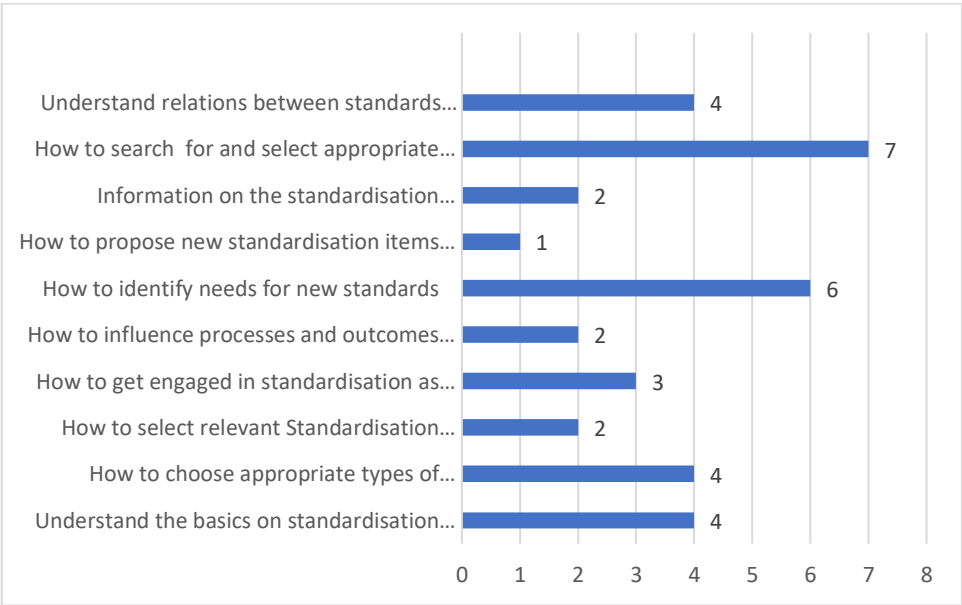

Figure 2: Type of support required by HS Booster.

"How to search for and select appropriate standards" and "How to identify needs for new standards" were the most selected options. It is noteworthy, that "Understand the basics on standardisation including basic terms", "How to choose appropriate types of standardisation from a R&I project" and "Understand relations between standards and regulations" received a significant proportion of responses, as some Consortium partners had never engaged in standardisation processes in the past and had limited overall knowledge. The internal survey is presented in Annex 2.

Following discussions within the Consortium, it was decided that the "How to get engaged in standardisation as observer or participant" type of support, although it received a low number of votes, would be the utter aim of PANTHEON during its interaction with HS Booster. Moreover, the "How to influence processes and outcomes of standardisation" was an equally important aspect for PANTHEON. "How to search for and select appropriate standards" and "How to identify needs for new standards" concluded the list of indicated types of support required by the Booster.

A logical question would arise: Why did not PANTHEON proceed with the initially indicated types of support? The answer to this question is related both to the description of the Task and to the ambition of the Consortium. T9.2 dictated the active participation and contribution of the project to the ISO 22361:2022 standard, which was under development at the time PANTHEON was at its proposal stage. Although the standard is published, the engagement of the project in current standardisation activities remains a priority and though there is no specific standard targeted by the Consortium, the exploration of relevant TCs, WGs and their work programme would pave the way for a vivid collaboration between PANTHEON and Standardisation Bodies. Moreover, considering that the Consortium opts for a high visibility of the project and its research and technological outcomes, engaging in standardisation processes would enable a persistent exploitation of the project results and the provision of feedback and recommendations to the EC for future research.

Already prior to the arrangement of online meetings with the assigned expert of HS Booster, T9.2 participants explored the standardisation landscape, with the focus being mainly on the safety, security and resilience as well as on the digital twin and smart city domains as these are the most indicative for the scope and objectives of the project. The purpose of this mapping was to detect relevant TCs, the working programme of which would be of interest to the project and its objectives and, furthermore, to facilitate discussions and navigate the HS Booster assigned expert to what PANTHEON aims to accomplish. The results of the mapping are presented in chapter 2. However, the core target of PANTHEON is on the following EU and international TCs:

- At the EU level:
  - CEN TC 391 "Societal and citizen security",
  - CEN/CLC/JTC 21 "Artificial Intelligence"
- At the international level:
  - ISO TC 292 "Security and resilience",
  - ISO/IEC JTC 1 / SC 41 "Internet of Things and Digital Twin"

3.3 PANTHEON AND HS BOOSTER INTERACTION

As already described, following the collaboration application, HS Booster assigned a specific standardisation expert to provide her guidance and advice to PANTHEON. This expert was Dr. Aikaterini Poustourli, whose extensive knowledge of the standardisation landscape and procedures proved extremely valuable for the project. Dr. Poustourli, with her engagement and active participation in both research projects and Standardisation Bodies provided significant inputs to PANTHEON. Indicatively, she has participated in past

standardisation-related projects such as STRATEGY, PRECICNCT and EU-HYBNET, whereas she currently provides her services not only in the context of HS Booster but also of the StandICT initiative. In addition, she is a member of the EC HOME Affairs Innovation and Security Research, the IEC SyC Smart Cities Open Forum and the DSA – Defense Standardization Advice, whereas she currently is the Head of the Civil and Emergency Planning Department of the International Hellenic University (IHU) and the convener of the recently reconstructed ELOT TC 104 "Protection against emergency threats and risk management", which is the Greek mirror committee of CEN TC 391 "Societal and Citizen Security" and of ISO TC 292 "Security and resilience".

The collaboration between PANTHEON and HS Booster was initiated in early 2024 and lasted approximately three months, during which a series of meetings between T9.2 participants and the HS Booster appointed expert took place. At the initial meeting the scope was to present, from the PANTHEON side, the objectives of the project and explain its needs and priorities, whereas, from the HS Booster side, to give an overview of the services provided by the programme as well as to share information about the standardisation fields indicated as interesting for PANTHEON. Over the course of the following meetings, the HS expert provided advice on specific actions that PANTHEON could carry out and also consultation taking into consideration the standardisation readiness level of the project. Concurrently, PANTHEON made actions based on the received advice, reassessing also its standardisation objectives.

The HS Booster expert, Dr. Poustourli, described, over the series of meetings with PANTHEON partners, the different paths to follow in order for a project to contribute to standardisation. These paths might include:

- **A standardisation roadmap**, where the current status of standardisation in a specific area is outlined, following extensive analysis of the topic. This path includes also concrete recommendations for future activities,
- **A standardisation strategy**, where standardisation proposals, that might address the scope of one or even several TCs, are put on the table and are relevant to innovative topics,
- **Contribution to a standard** under development/revision or suggestion for a new working item following a deep gap analysis,
- **Liaison**, where the project can contribute to ongoing discussions, participate in Working Groups meetings and provide recommendations and comments, albeit without voting rights.

Dr Poustourli pinpointed specific TCs, WGs and standards that could interest the project. With regards to WGs, she proposed the following, which could be approached in order to combinedly explore whether there are opportunities for PANTHEON to get engaged in their activities and standardisation projects:

Table 7: Proposed SBs, TCs and WGs by the HS Booster expert

Standardisation Body	Technical Committee	Working Group
CEN	TC 391 "Societal and Citizen Security"	WG 3 "Risk, resilience and emergency/crisis management"
CEN/CLC	JTC 21 "Artificial Intelligence"	WG 1 "Strategic Advisory Group (SAG)"
		WG 2 "Operational aspects"
		WG 3 "Engineering aspects"
		WG 4 "Foundational and societal aspects"
		WG 5 "Joint standardization on Cybersecurity for AI systems"

ISO/IEC	JTC 1 “Information technology”	SC 41 “Internet of Things and digital twin”

Through the discussions, it became apparent that the engagement of PANTHEON in ongoing or future projects of the aforementioned Committees would be beneficial in two ways:

a) Project-wise, the engagement in ongoing activities would bring significant added value to the Consortium and the actual outcomes of the project i.e., the under-development SCDT technology as well as the community engagement in DRM,
b) The expertise of the PANTHEON Consortium would provide considerable inputs to TCs. Regarding technical TCs, PANTHEON could introduce CM as a field of application for Smart City and Digital Twin Technologies, whereas for CM-related TCs, the engagement of the community in the overall DRM process, building mainly on the research results of the project and specifically of WP2 “PANTHEON Approach For Building Disaster-Resilient Communities”, would be a crucial suggestion.

PANTHEON INTERACTION WITH STANDARDISATION BODIES AND RECOMMENDATIONS FOR FUTURE STANDARDISATION

Although the interaction of HS Booster and PANTHEON was concluded within the projected three months, by summer 2024, the collaboration with Dr. Poustourli significantly increased the visibility of the project within standardisation cycles. As the convener of the ELOT TC 104 and thus having an official role in the standardisation sector, Dr. Poustourli organised online meetings between TCs and PANTHEON to discuss the potential engagement of the project in ongoing activities.

4.1 PANTHEON INTERACTION WITH STANDARDISATION BODIES

In December 2024, PANTHEON partners participated in an online meeting with representatives of the ISO/IEC JTC 1 JWG 16 "City information modelling and urban digital twins and similar initiatives global survey" and of the Unione Nazionale per lo Sviluppo e l'Innovazione in Settore Informatico (UNINFO). UNINFO directly participates in ETSI and comprises the Italian representative in international SBs e.g., ISO and IEC. UNINFO is part of the Italian SB "UNI" and is responsible for the development of technical standards relevant to AI, automation, blockchain and other ICT-related activities. During the meeting, vivid discussions were held. The outcome of this meeting was the proposal for PANTHEON to participate in an ongoing survey, jointly developed by IEC SyC Smart Cities, ISO/IEC JTC1, ITU-T SG20 and the OGC, the aim of which was to gain insights with regards to the current developments and SotA in City Information Modelling (CIM) and Urban Digital Twins (UDT). The survey targeted stakeholders and projects directly related to the development of CIM and UDT technologies and its objective was to identify gaps providing feedback to the developing IEC TS 63526 ED1 standard "Gap Analysis on Standards Related to City Information Modelling and Urban Digital Twins", expected to be published by the end of 2026. The survey and responses of PANTHEON are included in Annex 3.

However, PANTHEON is not solely a technically oriented project. On the contrary, the project has conducted in-depth research on disaster risk management and specifically on the mapping of existing civil protection and DRM plans and strategies at the international, EU and national level (for the pilot areas, Greece and Austria), on the hazard identification and risk assessment of the project pilot areas and, most importantly, on the involvement of the community and especially of vulnerable groups, in the overall CM process.

Although the project had already contributed to the technical domain and specifically to CIM and UDT-related committees, the ambition was to get even more involved into standardisation, although this time aiming at TCs relevant to security and resilience and specifically at CEN TC 391. Considering also the fact that Dr. Poustourli is the convener of the ELOT TC 104, a great opportunity was presented to directly communicate with TC 391. This committee consists of three WGs, WG1 "Healthcare Facilities", WG2 "High risk hazards and CBRNE" and WG3 "Risk, resilience and emergency/crisis management". The latter two WGs can be considered relevant to the work of PANTHEON. WG2 has already published three standards, the EN 17173:2020 "European CBRNE glossary", CEN/TS 18053-1: 2024 "Digital Chain of Custody for CBRNE Evidence-Part 1: Overview and Concepts" and CEN/TS 18053-2:2024 "Digital Chain of Custody for CBRNE Evidence-Part 2: Data Management and Audit". WG3 has published the EN ISO 22361:2022 "Security and resilience – Crisis management – Guidelines" standard, which is the one initially targeted by T9.2 (CEN/CLC, 2025). Although the current working programme of the aforementioned WGs does not include the development or revision of standards, several thoughts for the development of a set of standards for global catastrophic risk-related issues are put to the table.

Dr. Poustourli organised a two-days physical event entitled “Global Catastrophic Risks” at the premises of the International Hellenic University (IHU) in Serres, Greece during the 3rd and 4th of April 2025. This event was a collaborative endeavour between the Civil and Emergency Planning Department of the IHU and CEN TC 391, specifically of the WGs 2 and 3. During the event, the conveners of these WGs and other distinguished experts had the opportunity to discuss on current challenges in the security domain and the management of natural and man-made disasters and emergencies, as well as on how stakeholders can capitalise on standards to develop a common language, harmonise operational procedures and facilitate technical interoperability. During the first day, the scheduled meeting of WG2 and WG3 was held with the participation only of authorised personnel, who are directly involved in the activities of CEN TC 391, whereas, during the second day, the event was open with the inclusion of sessions and presentations relevant to disaster management. PANTHEON was invited and physically participated in this event, with the scope being twofold:

a) To present and disseminate the project and its developments to a disaster management and civil protection-related audience, increasing its visibility among the relevant stakeholders, but most importantly
b) To present the project to CEN TC 391 and make specific recommendations, building upon the achievements of the project, to be considered either as new working item proposals (NWIPs) or as inputs for potential future standards of WGs 2 and 3.

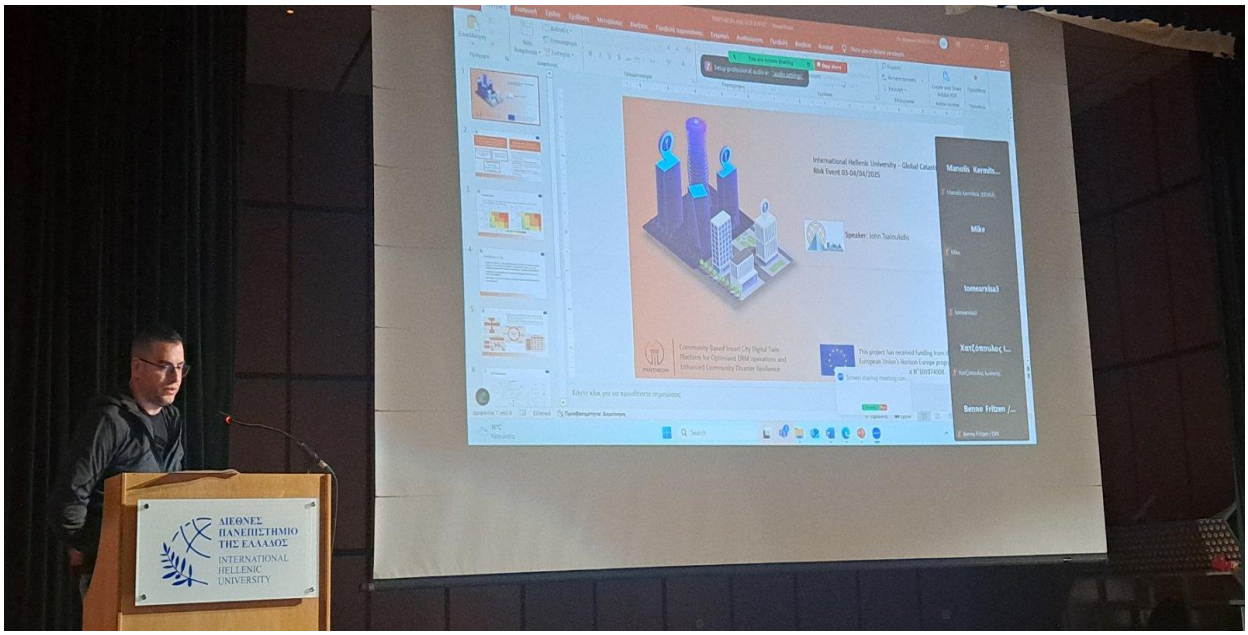

Figure 3: Presentation of the PANTHEON project at the "Global Catastrophic Risks" event at the IHU.

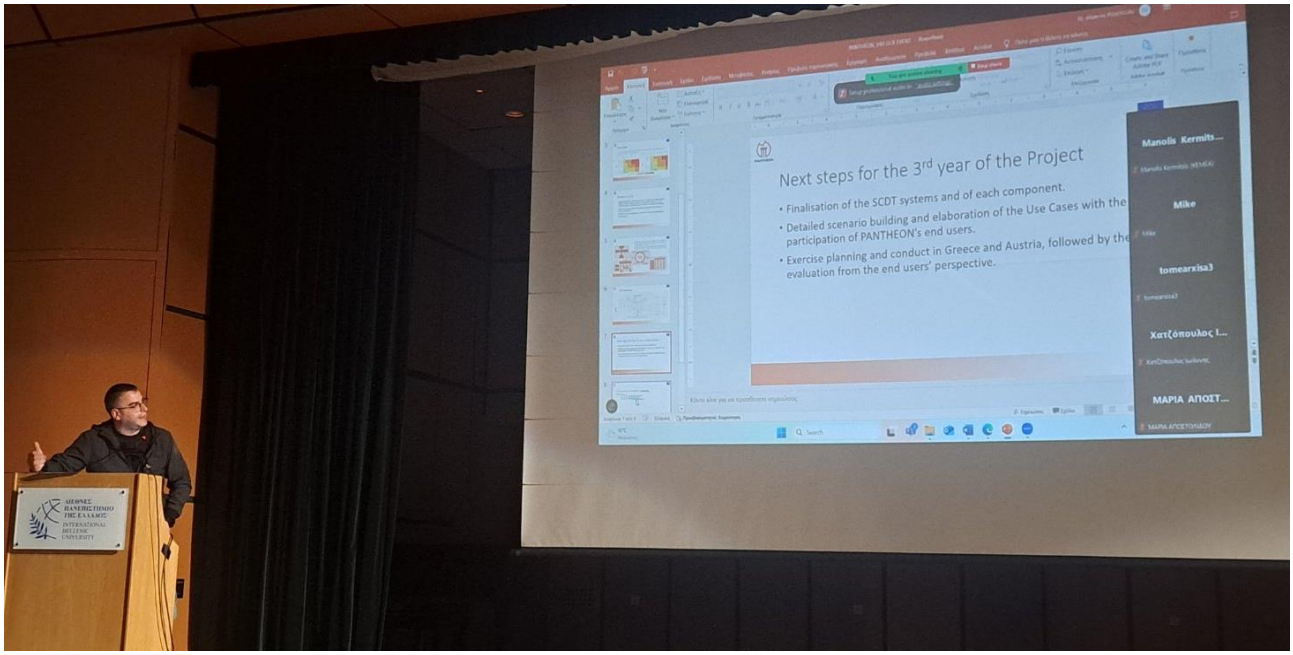

Figure 4: Presentation of the next steps of the project to the "Global Catastrophic Risks" event audience.

In the following chapter, the recommendations of the PANTHEON Consortium to CEN are elaborated.

4.2 PANTHEON RECOMMENDATIONS FOR FUTURE STANDARDISATION UNDER CEN TC 391

PANTHEON is built on two main axes:

- the development of the PANTHEON system, a SCDT tool, that can be used for both the response planning of first responders' organisations and the facilitation of their training procedures and
- the engagement of the community as an active player in the overall DRM process.

This twofold approach explains also the Consortium's willingness and intention to build communication bridges with technically oriented SBs as well as with TCs relevant to safety and security in general. The presentation of the project in the "Global Catastrophic Risks" event, the involvement in the internal meeting of WGs 2 and 3 as well as the participation in the online survey of IEC SyC Smart Cities, ISO/IEC JTC1, ITU-T SG20 and the OGC for the identification of gaps and the further development of the IEC TS 63526 ED1 standard justify the intent of the project to become an active player in the standardisation domain.

As soon as the event was announced, the PANTHEON Consortium and more specifically T9.2 participants worked intensively to identify areas, where the project provided significant added value, that could be considered as direct suggestions to the EC and CEN TC 391 and shape the future of CM research and respective standardisation. The work undertaken under the framework of WP2 "PANTHEON Approach for Building Disaster-Resilient Communities" and more specifically of Tasks 2.1 "Analysis of CBDRM National and Regional Policies, existing platforms and uptakes", 2.2 "Regional Multi-Hazards/risk data and assessment" and 2.3 "Community vulnerability and capacity assessments" is the main source of the standardisation recommendation presented below.

Overall, WP2 entails a holistic risk assessment for the pilot areas of the project i.e., Attica, Greece and Vienna, Austria. But what does the term "holistic" mean? PANTHEON utilised widely accepted risk assessment methodologies but further enriched them introducing the accumulation and description of the disaster management civil protection plans and regime in the pilot areas as well as the assessment of the vulnerabilities and capacity of the respective communities.

Delving deeper into the proposed community-based risk assessment methodology, three distinct steps can be recognised:

1. The identification and analysis of all natural and anthropogenic hazards that can potentially affect the area, for which the assessment is conducted. According to Triantafyllou et al. (2024), PANTHEON follows a Multi-Hazard Impact Methodology (MHIM), commonly used by CM stakeholders (researchers, practitioners and policy makers), with the aim of better understanding not only individual hazards but also interdependencies between them. Moreover, an analysis of the potential impact on the community and infrastructures is included in the MHIM approach. There are three key steps in the MHIM:
    - Hazard identification and characterisation, in which the hazards as well as the likelihood and severity of their occurrence are identified. A characterisation in terms of nature, magnitude and potential impact follows. This step is crucial for the development of appropriate civil protection and disaster management plans and strategies.
    - Exposure analysis, in which exposed factors e.g., infrastructures, demographic characteristics and the economy of the area of interest are examined.
    - MHIM analysis, which is a semi quantitative approach that focuses on the assessment of the compound effects of the multiple hazards

    The basis for the MHIM is on literature review (past events, frequency of occurrence and impact on assets at stake), combined with interviews with experts, ranging from researchers and scientists to first responders, civil protection authorities and vulnerable groups representatives, introducing a first level of community engagement in the overall risk assessment methodology. The findings and results from the desk research and the interviews with stakeholders are used for the creation of risk matrices (Likelihood-Impact) for the under-examination areas. Details can be found in D2.2 (The PANTHEON Consortium, 2024).
2. Mapping and analysis of civil protection and crisis management strategies and plans. Tsaloukidis et al. (2023) have conducted and structured the analysis on the basis of three levels:
    - The global and European level,
    - The national level, for the countries under examination,
    - The regional level again for the areas/regions under examination.

    The followed approach starts at the highest level, describing and analysing the Sendai Framework and other initiatives, such as EC Directives, then downscales at the national strategies and plans and finally reaches local/regional strategies for the examined areas. Moreover, interviews, mainly with practitioners (first responders, civil protection etc.), were conducted, which provided further input on how the strategies are implemented. Details with respect to the current status of international, EU, national and regional civil protection strategies and plans can be found in D2.1 (The PANTHEON Consortium, 2023).
3. Community vulnerability and capacity assessment with a focus on vulnerable groups. The analysis, can be clustered in two main parts:
    - one part is related to the comparison of different profiles of groups of people (in terms of social, economic and physical characteristics) and their vulnerability against the identified

hazards. Kainz et al. (2023) explain that another crucial point is the operationalisation and measurement of the community resilience, an aspect, although well researched, still lacking implementation mainly at a CM policy development level. The creation of relevant KPIs to measure the resilience of the community in the pilot areas of the project was an integral part of the vulnerability and capacity assessment.

- the second part is related to the identification of a vulnerability and capacity assessment methodology that will pinpoint gaps between vulnerability and current risk management mechanisms in the areas that are examined. The participation of the community and especially of vulnerable groups is important, as they have specific needs that need to be understood and considered by stakeholders, especially practitioners and policy makers. The inclusion of vulnerable groups in the overall VCA and risk assessment process is beneficial both for the vulnerable population as well as for the DRM community as communication channels can be built for both groups. Details regarding the VCA methodology can be found in D2.3 (The PANTHEON Consortium, 2023).

Building on the findings of D2.3, vulnerability can be both physical e.g., location of settlements near/far from hazardous areas, critical infrastructures that lower risks (dams etc.), and social, including socioeconomic parametres and demographic factors. Both types of vulnerability are interrelated. The Council of Europe with a published document dictates the increase of protection measures for vulnerable groups e.g., homeless, disabled people etc., as disasters will likely increase their vulnerability (Prieur, 2012). For PANTHEON, vulnerable groups are considered people with characteristics that put them at higher risk of injury, death, financial or other ruin during or after a disaster situation. These characteristics can be physical, such as the construction material of houses, and social, such as financial means or physical or mental disability. Vulnerability and Capacity Assessment (VCA) is a method to assess the risks (e.g., health risks, disaster risks), vulnerabilities to those risks and capacities to cope with those risks in a certain location, the scope of which can reach from the household- to the national-level. The goal is to collect data that can be analysed to enable planning for and preventing hazards, as well as reducing the identified risks and vulnerabilities and building capacities, so that when hazards strike, their effects are mitigated (The PANTHEON Consortium, 2023).

According to Kainz et al. (2023) the VCA should include five steps:

1. Define the scope of the assessment,
2. Facilitate the design of the assessment,
3. Collect all relevant data,
4. Conduct data analysis and
5. Report and dissemination of the results.

The methodology of the VCA is participatory, meaning that the communities should be involved not only in the data collection, but also in the decision processes when it comes to implementing policies. The intention of a VCA is to assist people and communities in preparing for hazards while drawing on their own capacities. Therefore, the methodology follows a bottom-up approach. Usually, the studied communities benefit directly from a VCA by improving their own understanding of the risks they face and the capacities they possess to deal with these risks.

Social vulnerability includes the following four factors:

- socioeconomic status e.g., income and education,
- household composition/ disability e.g., two-parent or single-parent household, people with disabilities, number of children or elderly,

- minority status/ language due to the social and economic marginalisation of certain ethnic groups and the difficulties for disaster communications related to language skills,
- housing/transportation, for instance living in poorly constructed houses or mobile homes, living in overcrowded areas, automobile ownership.

As major vulnerable groups are considered children, the elderly, women and people with disabilities. However, depending on the characteristics of a disaster other vulnerable groups can be affected. T2.3 developed the following table, which depicts potential vulnerable groups, vulnerability indicators and the vulnerability dimension.

Table 8: Potential vulnerable groups and indicators-dimensions affected by a disaster, Source: D2.3 "Community Vulnerability and Capacity Assessments

Vulnerable groups	Vulnerability factor/Indicator	Dimensions
People with low income	Financial resources	economic
Children/minors	Age/ability to act, mobility problems	social and physical
Elderly people	Age/ability to act, mobility problems	social and physical
Pregnant people	Pregnancy/physical condition	social and physical
Single parent families with minor children	Parenthood/ role or responsibility and duty of care	social and economic
Homeless people	Financial resources and social involvement, living conditions	social, physical and economic
People with mental disorder/disability/illness	Mental health	social
People with physical disorder/disability/illness	Physical health, mobility problems	physical
Migrants, refugees, asylum seekers	Migration background, language issues	cultural and political

As already described, throughout the whole process of WP2, community members were interviewed and asked to participate in online questionnaires in order to provide their viewpoint and shape directions to be followed with the aim to make community involvement an integral part of the risk and vulnerability/capacity assessment of an area. Overall, interviewees and survey participants include first responders, civil protection organisations, policy making authorities, heads of schools, representatives of mental and physical disability associations, hospital personnel, representatives of organisations supporting women, representatives of

charity institutions, personnel working in nursing homes or for refugees and immigrant groups, technological providers, NGOs performing community work and other public authorities. The compilation of the, overall, three implemented methodologies i.e., desk research, dissemination and analysis of the questionnaire results and the interview conduct with community representatives, provide a holistic assessment and a two-dimensional risk analysis encompassing both the hazard and the community vulnerability elements.

The methodology followed by the PANTHEON project for the VCA has a strong foundation and is already followed by organisations e.g., the International Federation of Red Cross and Red Crescent Societies (IFRC). According to Cannon and Kirbyshire (2011), VCA should be established as a participatory tool in order to identify the needs and priorities of the community and engage citizens to deal with these needs. Moreover, VCA should not only be considered as a tool solely for DRM but rather as a generic methodology, which can be implemented in various circumstances. The outcomes of a well-structured VCA should provide feedback to stakeholders relevant to disaster management, health, water and sanitation and assist them in developing new and revising existing plans and strategies. The study strongly highlights the need for a standardised methodology to conduct a VCA and evaluate its outcomes and strongly recommends relevant organisations to organise discussions for the development of a uniform VCA methodology. The following schema depicts the Enhanced Vulnerability Capacity Assessment (EVCA) proposed by the IFRC, which follows a similar step by step methodology with PANTHEON.

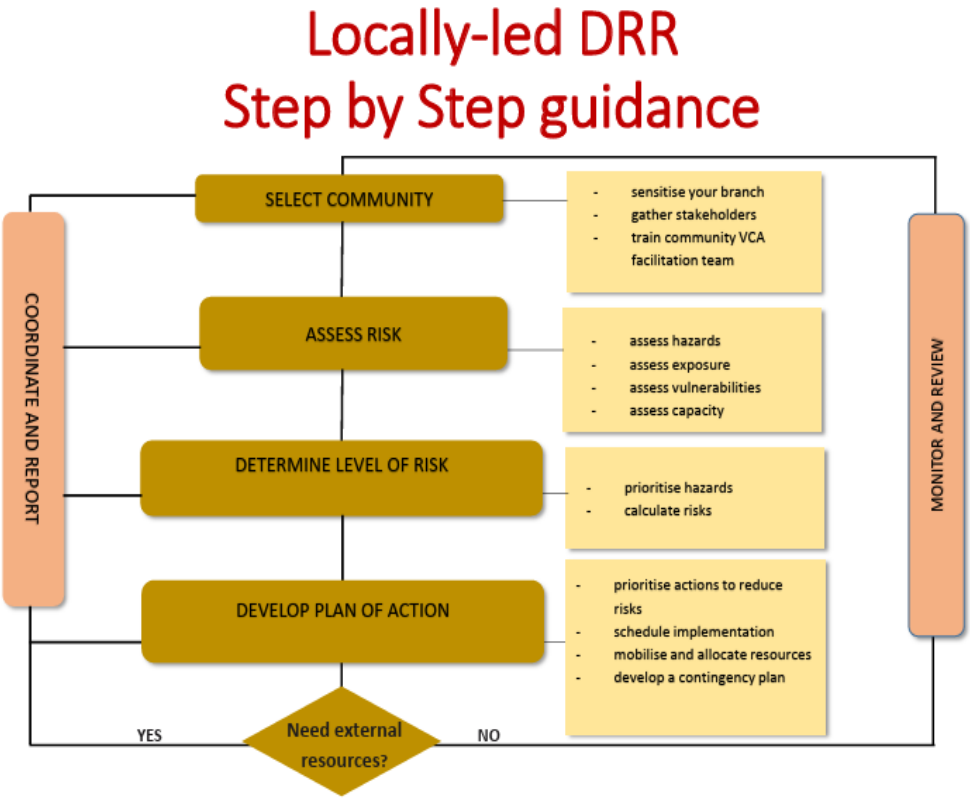

Figure 5: IFRC guidance for a detailed Disaster Risk Reduction (DRR) and EVCA methodology at the local level, Source: IFRC

Concluding, risk assessment, for a specific area, with the use of semi quantitative matrices measuring the likelihood of occurrence and expected impact comprises a well-established and widely used methodology to identify hazards and examine the impact of their occurrence on assets e.g., lives, livelihoods, the economy, the environment and the infrastructures. However, the added value brought by PANTHEON and suggested

to CEN TC 391 during the “Global Catastrophic Risks” event, is the aforementioned inclusion of the community of a specific area in all the processes of DRM and most importantly, the VCA of the community to become an integral part of the overall DRM plans for the named area.

CONCLUSIONS

Throughout the first 30 months of the PANTHEON project, the Consortium explored various ways in order to overcome the obstacle, that emerged with the publication of ISO 22361:2022 which was the core target of T9.2 and the respective activities dictated in the DoA. Even prior to communicating with the HS Booster initiative, the Consortium and Task participants created a map of SBs, TCs and WGs, the objective of which is to develop standards that could be directly or indirectly linked to disaster management and civil protection. Another significant topic of interest was identifying committees, which develop standardisation documents relevant to technological domains such as AI, DT and Smart Cities. The reason for this technically oriented research was that PANTHEON aims not only to strengthen the CM domain by introducing the community as an active player in DRM, but also to develop a SCDT technology, that will facilitate first responders' training and operational planning. Besides, training and planning are the actual use cases identified and used as a basis for the development of the scenarios of the guided TTXs taking place in September and November 2025.

The desk research revealed a significant number of committees, to where PANTHEON could contribute. However, establishing communication with SBs is not always easy and requires large timeframes, which are likely to exceed project durations. This is one of the main reasons for the initiation of the HS Booster programme i.e., to facilitate projects communicate with SBs and explore areas in which projects could contribute. PANTHEON, having already formed a map of interesting TCs, established communication with HS and received valuable guidance and consultation from Dr. Poustourli, a standardisation expert assigned by HS to assist PANTHEON. A series of meetings were held, which proved very insightful for the project as they paved the way for increasing the project's visibility and communicating with SBs.

Although the interaction between PANTHEON and HS had to be concluded within a timeframe of three months, the efficient collaboration with Dr. Poustourli endured and through her the project had the opportunity to discuss with conveners of national and EU SBs and partake in ongoing activities, the most notable of which was the participation in a dedicated survey that serves the ongoing work for the under development IEC TS 63526 ED1 standard "Gap Analysis on Standards Related to City Information Modelling and Urban Digital Twins". The inputs of the project provided significant feedback, considering that the development of the SCDT technology is the technical objective of the project.

However, the most important involvement of PANTHEON in standardisation procedures, was its participation in the "Global Catastrophic Risks" event, which was organised by Dr. Poustourli in the premises of the International Hellenic University (IHU) in early April 2025. In this event, the internal meeting of CEN TC 391 WGs 2 and 3 were held, during which PANTHEON was presented along with the project's specific recommendations to be considered for the current working programme and potential new standards.

PANTHEON recommends the enrichment of the overall emergency and disaster management planning with the involvement and engagement of the community and specifically of vulnerable groups. Building upon the outcomes of WP2 "Approach to Building Disaster Resilience Communities" and specifically of T2.1 "Analysis of CBDRM National and Regional policies, existing platforms and uptakes", T2.2 "Regional Multi-Hazards-risk data and assessment" and T2.3 "Community vulnerability and capacity assessment", PANTHEON proposes to encompass the community in risk assessment methodologies and also in the assessment of the vulnerability and capacity of the society (VCA), as the latter plays a significant role in determining the impact from the occurrence of hazards in a specific area. The VCA includes the identification of vulnerable groups, their specific characteristics as well as the estimation of how and to what extent they might be affected by the various hazards that can occur in the examined area.

The above recommendations were discussed with the conveners of WG 2 and WG3 and further meetings are expected to take place within 2025 among the PANTHEON Consortium, the Hellenic Standardisation Organisation (ELOT) TC 104 “Protection against emergency threats and risk management” and CEN TC 391 “Societal and citizen security”. It is noteworthy that, on one hand this Deliverable does not mark the end of T9.2, which spans throughout the whole project lifetime (M36, December 2025) and enables relevant activities to continue after the submission of the current Deliverable (M30, June 2025), on the other hand standardisation discussions and potential actual contribution to future standards of the above WGs might exceed the duration of PANTHEON but will significantly increase the prestige of the project and lead to the capitalisation of its results by both the EC and CEN in order to draw future research.

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ANNEX 1: PANTHEON APPLICATION TO HS BOOSTER

Grant Agreement Number: 101074008

Project Acronym: PANTHEON

Full Project Name: Community-Based Smart City Digital Twin Platform for Optimised DRM operations and Enhanced Community Disaster Resilience

Funding Programme: Horizon Europe

Funding Programme Detail: Cluster 3 Civil Security for Society

Call Topic ID: HORIZON-CL3-2021-DRS-01-01

Project Website: https://pantheon-project.eu/

Project Officer Name: Jana Paskajova

Open Call Topic: Civil Crisis Preparation, Emergency Management, Digital Twins

Support your Project requires: How to search for and select appropriate standards, How to identify needs for new standards, How to get engaged in standardisation as an observer or participant, How to influence processes and outcomes of standardisation.

Short description of the project and its standardisation objectives: PANTHEON will design and develop a Community based Digital Ecosystem for Disaster Resilience utilising Smart City Digital Twin (SCDT) technology and leveraging new and emerging technologies and innovations to improve risk assessment, reduce vulnerability, and building community disaster resilience. The aim is to enhance the operational capabilities of CBDRM (community based DRM) teams, by: a community based smart city digital twin environment with components used for simulations, training and evaluation of the behaviour of sub-systems, threats and human factor; an early Detection and Situational awareness environment enabling authorities and FR and SR (first and second) even in complex, remote and demanding locations; an integrated intelligent subsystem, by the utilization collaborative sensing from earth observations and swarms of UAVs optimized to autonomously perform UAV-assisted operations throughout all disaster phases. PANTHEON platform and technologies will be combined with IoT infrastructure, multi-source data (satellite and in situ data, social networks, historical data) to create a tool for assessment of risks, vulnerability and capacity assessment; disseminate and inform decision makers and the public for risks during disasters; engage citizens and stakeholders in the disaster resilience building and share knowledge and best practices; identify vulnerabilities and implement policies, strategies and plans to eliminate future disaster costs; enhance collaboration among people at the local level; promote the conduct of comprehensive surveys on multi-hazard disaster risks and the development of regional disaster risk assessments and maps, including climate change scenarios; promote and enhance, through international cooperation, including technology transfer, access to and the sharing and use of non-sensitive data and information; SCDT will enable collective community behavior into the assessments of exposure to urban multi-hazards across time and space.

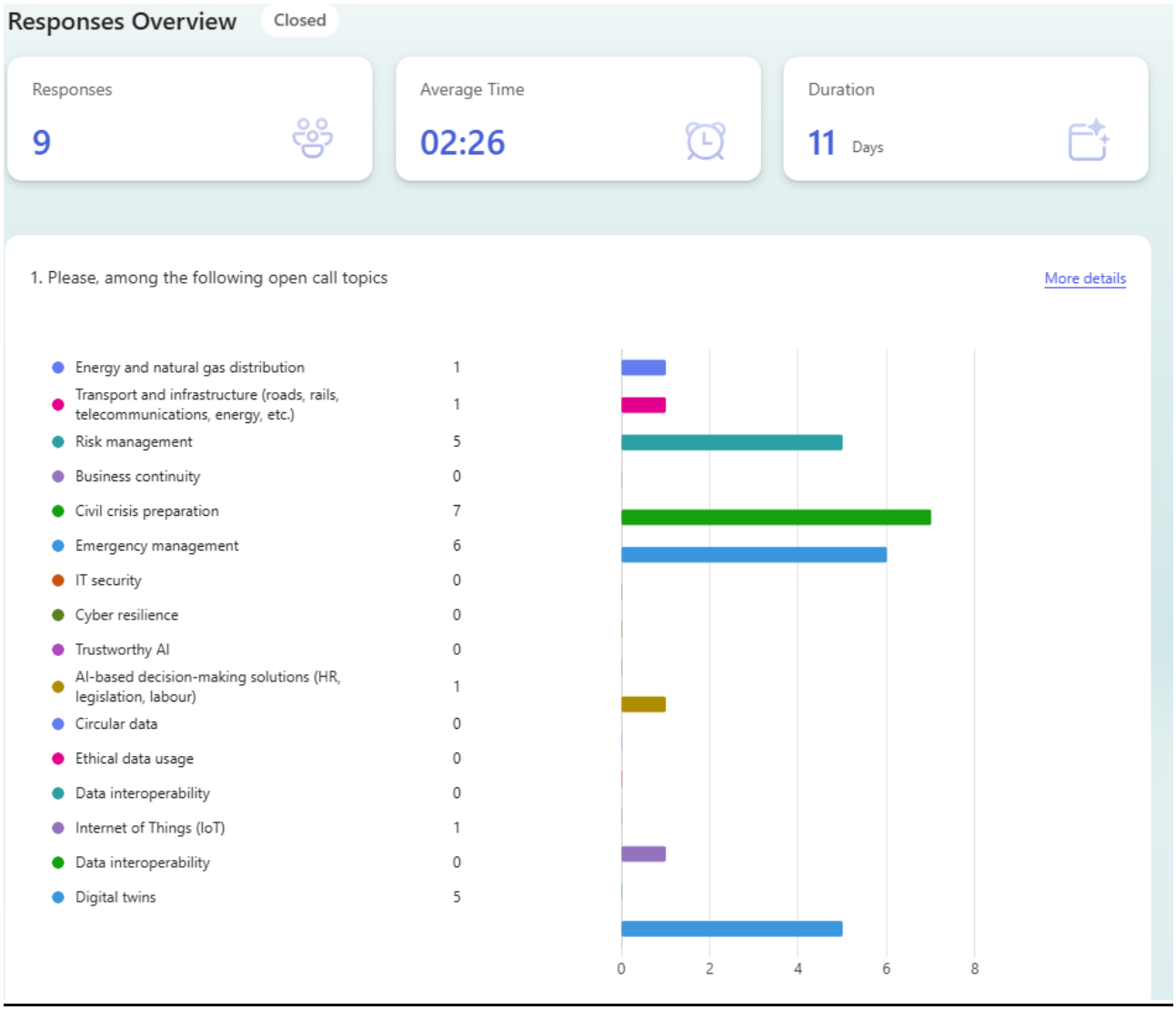
The Project aims to increase its impact and the quality of its outcomes by participating in standardisation activities. The Consortium will identify specific standardisation bodies and technical committees to engage with and take part in the development of a new standard or the revision of existing ones, bringing forth the expertise of project partners and the overall experience acquired throughout the implementation of the project and the development of the Smart City Digital Twin, which is the main outcome of PANTHEON.

Why are you applying for a Standardisation Booster service: At this stage, the Consortium is trying to identify in which ways to engage with standardisation activities. Although HS Booster provides a variety of selections, regarding the support that PANTHEON requires, the Consortium has decided to opt for the categories of "How to search for and select appropriate standards", "How to identify needs for new standards", "How to get engaged in standardisation as an observer or participant", "How to influence processes and outcomes of standardisation". However, our main target is to somehow participate in the development of a new standard, either if it already is at the stage of development, or even if it is at a preliminary stage. Another option would be to participate in the revision of existing standards. We believe the experience that project partners will gain through the development of digital twin technologies for disaster and crisis management purposes, will provide significant inputs to standards of a similar topic and even broaden the spectrum of digital twin technology applications, incorporating crisis management. The Consortium has already conducted research regarding relevant SDOs and Committees, however further consultation from HS Booster would be welcome, as the experts of the programme can pinpoint other SDOs and TCs or even specific under development standards that could be of interest for PANTHEON.

SDO/NSB/NC: ETSI, CEN/CLC, ISO/IEC, IEEE, ELOT

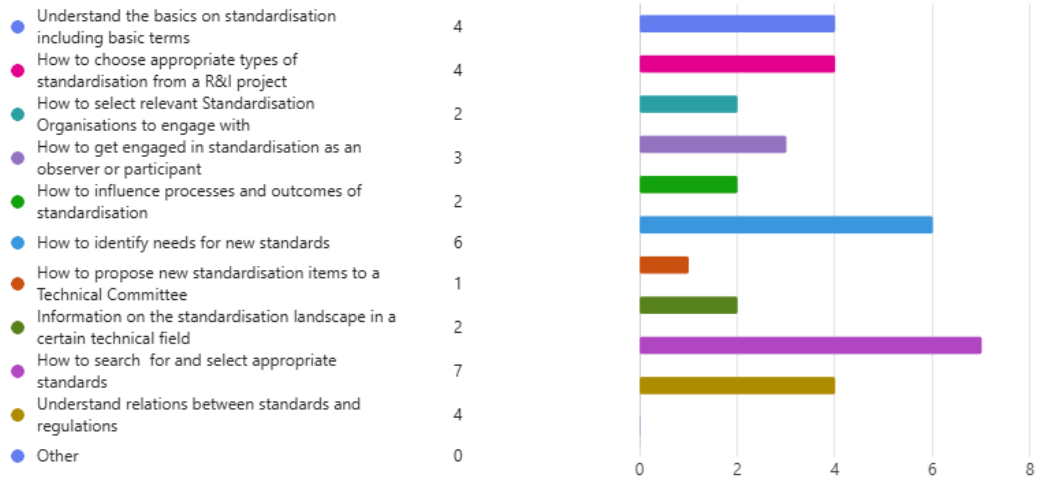
TC: ISO/IEC JTC 1/SC 41, ISO/IEC JTC 1/SC 42, CEN/CLC/JTC 21

ANNEX 2: PANTHEON – HS BOOSTER INTERNAL SURVEY



2. Please, select the type of support PANTHEON requires (multiple selection available)

More details



3. Are you aware of or engaged in any under-development or under-revision standards, that you would like the PANTHEON consortium to participate in? Please indicate the Standardization Body, the relevant Technical Committee and the code of the standard.

2 Responses

ID ↑	Name	Responses
1	anonymous	no
2	anonymous	We have been engaged in the past in the development of disaster management-related standards and CWAs, within the context of CEN TC 391 - Societal and Citizen Security

ANNEX 3: CITY INFORMATION MODELLING, URBAN DIGITAL TWINS AND SIMILAR INITIATIVES GLOBAL SURVEY

Response Summary

Have you ever used or been involved in projects involving City Information Modelling, Urban Digital Twins or similar initiatives?
Yes

What is the name of your project involving City Information Modelling, Urban Digital Twins, or similar initiatives?
PANTHEON, Community-Based Smart City Digital Twin Platform for Optimised DRM operations and Enhanced Community Disaster Resilience, GA: 101074008

Please use one to two sentences to describe your project in a way that someone outside your project can understand.
PANTHEON will design and develop a community based Digital Ecosystem for Disaster Resilience utilising Smart City Digital Twin (SCDT) technology and leveraging new and emerging technologies and innovations to improve risk assessment, reduce vulnerability, and building community disaster resilience. The aim is to enhance the operational capabilities of CBDRM (community based DRM) teams, by: a community based smart city digital twin environment with components used for simulations, training and evaluation of the behaviour of sub-systems, threats and human factor; an early Detection and Situational awareness environment enabling authorities and FR and SR (first and second) even in complex, remote and demanding locations; an integrated intelligent subsystem, by the utilization collaborative sensing from earth observations and swarms of UAVs optimized to autonomously perform UAV-assisted operations throughout all disaster phases.

What is/has been your primary role in the project as the respondent of this questionnaire?
University/research institute

What is your primary role in the project? (Multiple answers allowed)
CIM/UDT project leader
Researcher

List of Countries
Greece

In which city or region is your project taking place?
Athens, Greece and Vienna, Austria

What is the geographical scope covered by your project?
Multiple specific locations (involves multiple specific sites or locations that are not confined to one particular city or region)

When did the project officially start? [Provide the year]
January 2023

What is the current status of the project?
In progress

Which sectors have you applied these technologies to/provide solutions to? (Multiple answers allowed)
Simulation, prediction and verification
Emergency management and rescue
Safety, security, resilience, defense
Disaster prediction and handling
Education

Who is the primary organizer or owner of the application/platform/technology/solution in this project?
Other (Please specify) -- The PANTHEON Consortium, including academic institutions, private companies and first responders' organisations.

What types of data do you primarily interact with when using this technology? (Multiple answers allowed)
Near real-time data (collected by using sensors)
Regularly updated data
Historical data

What data do you primarily interact with when using this technology? (Multiple answers allowed)
Environmental data
Geospatial data
IoT data
Photos and aerial photos
Satellite data
Road and transport data
Urban infrastructure data
Demographic and social data (e.g., population data)
Disaster and emergency service data
Citizen feedback data
Accessibility data (e.g., for people with disabilities)

What are the most important kinds of technologies used in your project? (Multiple answers allowed)
GIS software
Urban digital twin platforms
Earth observation services
Artificial intelligence (AI)
Simulation tools
IoT
Cloud computing
Big data tools

Please name the most important software packages that you have utilized in your projects.
ArcGIS, QGIS, Docker, Minio, KAFKA, Leaflet, Paparazzi, ROS, OpenCV

What software features are most critical for your project's success? (Multiple answers allowed)
Real-time data processing
3D visualization/geo-visualization
Data integration capabilities
Simulation and modeling
Data exchange/interoperability
Scalability

What are the primary programming languages or development environments used in your project? (Multiple answers allowed)
Python
JavaScript
Java
Other (Please specify) -- C++

What challenges have you faced with the technologies/tools used in your project?
Data interoperability and integration.

In your CIM/UDT project, how do you bring in data from underlying data sources? (Multiple answers allowed)
Manually copying data into CIM/UDT environment
Automated batch update
Real-time connections to underlying data sources

Do your CIM/UDT solutions communicate with CIM/UDT solutions of other organizations?
No

Have you established any integrations between your CIM/UDT solutions and other IT applications/systems/solutions in your organization?
No

Have you used IoT functionality to establish twinning capabilities in your CIM/UDT solution?
Yes, by using an IoT platform/IoT management system

What application areas (e.g., air quality, traffic, water management) do you use sensors, actuators and other IoT devices for?
Meteorological sensors, traffic data and drone imaging.

Are you using or planning to use any AI technology and functionality within or in conjunction with your CIM/UDT solution? Please describe.
Yes. We are using AI technologies for analyzing patterns in historical data (e.g., traffic) and making predictions for disaster management (e.g., blocked roads, traffic prediction, routing adaptation, decision support).

Have you implemented or are you planning to implement any CitiVerse or Metaverse technology and functionality within or in conjunction with your CIM/UDT solution? Please describe.
No.

Are you aware of any standards you are currently using in your projects involving CIM/UDT/similar technology? Please provide a list including the standard number, year, and title.
No.

Are you aware of any challenges encountered while implementing these standards? Please describe.
No.

Are you aware of any specific areas where you feel current standards are lacking or inadequate? Please describe.
No.

Your name (Format: Given name, Middle name, Family name)
Anna Tsabanakis, Mike Karamousadakis, John Tsaloukidis, Danai Kazantzidou-Firtinidou

Your job title
Project managers, Standardisation managers

The name of your organization
TWI HELLAS, KENTRO MELETON ASFALEIAS

How many years of experience do you have working with City Information Modelling (CIM), Urban Digital Twins (UDT), or similar initiatives? [Provide the number of years]
2 years.

Do you have the experience of working for global/national/regional/local/other types of standards?
Yes

Your email address (you will receive the report of response when you fill your valid email address):
j.tsaloukidis@kemea-research.gr

Thank you for participating in this survey. Your responses are invaluable in helping guide future standardisation. This is the first phase of the global survey, and we will have the second phase to collect detailed case studies of CIM/UDT/similar initiatives globally. Would you be interested in submitting a case study of your project? (Case studies chosen to be included in the report will gain valuable publicity.)
Yes and I have filled my contact information through the questions above