D8.7 Trials assessment and recommendations

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[1] **R**=Document, report; **DEM**=Demonstrator, pilot, prototype; **DEC**=website, patent fillings, videos, etc.; **OTHER**=other

[2] **PU**=Public, **CO**=Confidential, only for members of the consortium (including the Commission Services), **CI**=Classified, as referred to in Commission Decision 2001/844/EC

Modifications Index

Date	Version
15/05/2023	0.1 ToC and initial content
02/06/2023	0.2 Draft version of D8.7
02/06/2023	0.3 CYRIC provided input for the questionnaire
07/06/2023	1.0 Complete version of D8.7
02/10/2023	2.0 Revised version of D8.7

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ACRONYMS AND ABBREVIATIONS

CH	Cultural Heritage
CI	Critical Infrastructure
DSS	Decision Support System
FR	Functional Requirement
HRAP	Holistic Risk Assessment Platform
NFR	Non-Functional Requirement
UI	User Interface
UR	User Requirement

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Executive Summary

Deliverable D8.7, namely "Trials assessment and recommendations", documents the work undertaken in Task 8.6 "Assessment and Recommendations".

A comprehensive technical and operational assessment has been conducted for the two accepted versions of the HYPERION integrated system (V1 and V2). The technical assessment is implemented at (i) a component-level, where the technical partners test their respective technical components and (ii) at a system-level, where the interaction of the components and their integration with the integrated platform is assessed. To quantify the results of assessments (i) and (ii), the technical partners are providing their input regarding the level of implementation of the HYPERION User Requirements (URs), as defined in D2.2. Subsequently, the deliverable delineates the operational assessment of the platform by means of demo evaluation and user feedback. Finally, several recommendations for the future are reported, as collected by the end-users during the training sessions at the last phase of the project.

1 Introduction

1.1 Background

Deliverable D8.7 "Trials assessment and recommendations" summarizes the work undertaken in Task 8.6, namely "Assessment and Recommendations". The assessment conducted in this task is implemented on two levels, (a) technical and (b) operational. A *technical assessment* pertains to the evaluation of the system's technical components and performance. It involves analyzing the underlying hardware, software, and network infrastructure, as well as the system's design, architecture, and security. Thus, the technical partners of the project bear the primary responsibility for the execution of assessment (a). An *operational assessment*, on the other hand, focuses on how the system functions in practice. This includes analyzing the system's performance metrics, end-user feedback, and other operational data to determine whether the system is meeting its intended goals and objectives. As a result, the operational assessment is typically conducted after each pilot test and training session, in order to assess the performance of the system and accommodate potential recommendations from the pilot partners.

1.2 Scope and objective

The overall purpose of Task 8.6 is to report the technical and operational assessment of the HYPERION system plus recommendations towards a future industrialized version. Thus, the present deliverable is closely interrelated with all deliverables of WP8, especially D8.5 "Final version of the HYPERION system and acceptance test" and D8.6 "Reports on pilot testing". In brief, the main objective of D8.7 is to:

- Report the technical assessment of both versions (V1 and V2) of the system based on the User Requirements (URs) described in D2.2 "Definition of System Requirements, Use Cases and KPIs Specification".
- Report the operational assessment of V1 and V2 during the pilot cases and training sessions by means of demo evaluation and user feedback.
- Address key recommendations to improve the usability, efficiency, and effectiveness of the system, as received by the end-users during the training sessions.

1.3 System development timeline

The integrated HYPERION system comprises a wide spectrum of cutting-edge technologies that aim to assist local authorities and cities at an urban planning and operational level, as well as Cultural Heritage (CH) and Critical Infrastructure (CI) operators during the maintenance and rehabilitation of critical facilities and assets. To deliver its purpose, the system processes data coming from different hardware and software components, engines, and assessment studies, which are made available to the user via the Holistic Risk Assessment Platform (HRAP) and the underlying Decision Support System (DSS). In particular, the main technical components of the system are the following (see Figure 1):

- **HRAP and DSS**, which facilitate the overall system integration as well as offer enhanced situational awareness.

- **Middleware**, which is responsible for the coordination of information delivery among the different components of the system (e.g., sensors, weather stations, engines, HRAP).
- **Hardware components**, which comprise smart tags, data cubes, and weather stations used for continuous monitoring of the micro-climate conditions within historic areas with vulnerable CH/CI assets.
- **Site-specific database customization**, which accounts for the customization of the system to capture the specific hazard/exposure/risk characteristics of the considered site. The database can be discretized further into the following sub-components:
    - Weather hazard database
    - Seismic hazard database
    - Flood hazard database
    - Material degradation database
    - Structural vulnerability database
    - 3D representation database
    - Socioeconomic Engine
    - Risk & Resilience Engine
- **Event-specific assessment component**, which employs a range of Computer Vision-CV Detection and Monitoring Systems that collect data from UAVs, ground stations, and satellites to realize (i) displacement maps, (ii) land cover change detection maps, (iii) hyperspectral image maps, and (iv) crack detection results.
- **Mobile App**, which delivers a community-based participatory environment for CH areas and is linked to the HRAP/DSS.

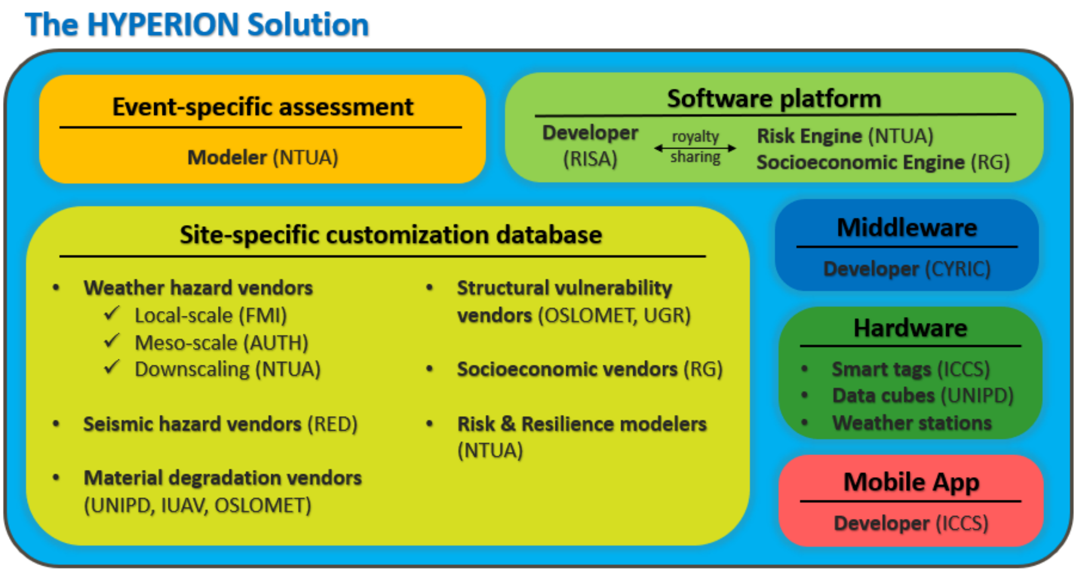


Figure 1: Main technical components of the HYPERION system

To integrate the plethora of technical components comprising the HYPERION system, the Hyperion verification and validation plan as documented in Deliverable 8.3 was followed. In particular, each component was first tested and validated in-vitro by the respective technical partners. Subsequently, the components were iteratively integrated, either directly or through the Middleware, into HRAP to form the integrated HYPERION system. Finally, the entire system was tested in-vivo through a series of virtual & physical pilots and the results of the assessments were used to fix issues and upgrade the components. As a result of this iterative process, two versions of the system were realized. The first version (V1), deployed in M29, comprised the first accepted version of the HYPERION system and was tested extensively during the 1st (M29-M34) and the 2nd (M37-M44) testing period. During this phase, the system was being updated continuously with unimplemented features missing from V1 as well as based on the technical and operational assessment after each pilot. At last, the Consortium released the second version (V2) in M44 while it continued addressing users' feedback and fixing any identified issues until the end of the project (M48). Figure 2 depicts the timeline of the system development along with the virtual and physical pilots that took place during the testing periods.

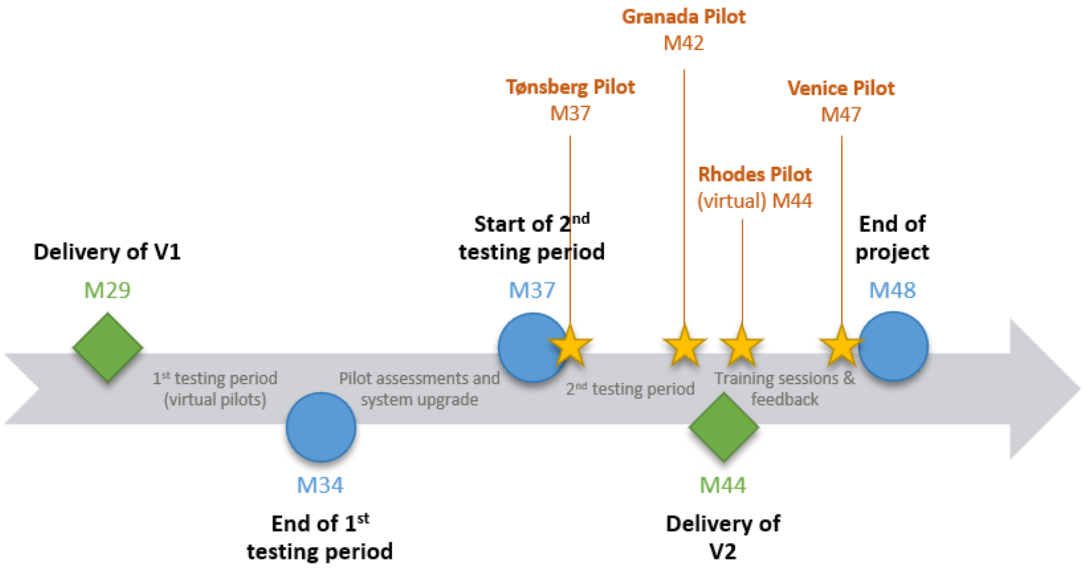


Figure 2: System development timeline

2 Technical Assessment

Throughout the project lifetime, the HYPERION system was extensively assessed and refined at (i) a component-level, where the technical partners tested in-vivo their respective technical components and (ii) at a system-level, where the interaction of the components and their integration with the HRAP platform was assessed. From a qualitative standpoint, V2 of the system showcased the desired behavior in terms of performance, accuracy, and integrity. This was achieved through monthly and bi-weekly meetings among the technical partners and in particular with CYRIC and RISA teams and the other technical partners, to secure integration of the components with Middleware and HRAP, respectively.

To quantitively evaluate the performance of the HYPERION system, technical assessments were conducted on the basis of the User Requirements (URs) emanated in D2.2 “Definition of System Requirements, Use Cases and KPIs Definitions”. The technical assessment against the URs was ongoing during the system components integration and the system testing phase for the HYPERION integrated release. The list of system tests and alignment to system requirements was presented in Deliverable 8.5. In this report, each UR is characterized by its ID, Type (Functional and Non-Functional), Priority, Category, Description, etc. The results of the assessments are showcased in Table 1 and Table 2 for the Functional and Non-Functional URs, respectively. Overall, in V1 most URs were near completion (status >80%), while in V2 an 100% implementation was achieved in almost all URs. Only a few requirements were not completely attained in V2, however either their priority was not compulsory or other means were employed to achieve the same functionality (see last column for remarks by the technical partners).

Table 1: Technical Assessment of the Functional Requirements (FRs).

ID	Description (Category)	Priority	V1 status	V2 status	Remarks (optional if UR is 100% in V2, mandatory if the UR was not fully met)
FR_1	User authorization procedure (General)	Must	100%	100%	
FR_2	Map classification (General)	Must	80%	100%	More details were added in V2 regarding Tier 3 buildings for all pilot sites.
FR_3	Types of threats monitored (General)	Should	80%	100%	In V1, flood hazard was included but with dummy data. In V2 real data for Venice were added, as well as free/thaw cycles + biological growth.
FR_4	Data acquisition from external systems (External Interfaces)	Could	100%	100%	The V1 of the system fetches meteorological data from public APIs for the pilots of Venice and Rhodes as well as seismic activity data for all pilot sites. Retrieved values are filtered based on predefined thresholds.
FR_5	Include all atmospheric parameters needed for the pilot areas (Atmospheric Models)	Should	80%	100%	In V1, data regarding atmospheric parameters originated directly from mesoscale model (MEMO) calculations. On the other hand, in V2 corresponding data were obtained both from model calculations data assimilation methods.

FR_6	Provide the output in commonly accepted format (Atmospheric Models)	Should	80%	100%	In V1, the output of our simulations was provided in PNG and NetCDF format, while in V2 GeoTIFF format was enhanced in our output. It should be noted that as regards the wind data, in the GeoTIFF format they are provided as a wind speed and wind direction combination, while in the NetCDF format they are given in the form of u-v components.
FR_7	Provide the output based on the agreed scenario and spatial resolution (Atmospheric Models)	Should	100%	100%	
FR_8	Provide air temperature and humidity (Smart Tags)	Should	100%	100%	Plus dew point temperature calculation.
FR_9	Record measurements at least once per hour (Smart Tags)	Should	100%	100%	48 sensor readings per day. Measurements every 30 minutes.
FR_10	Push data daily to the backend (Smart Tags)	Should	100%	100%	
FR_11	Function availability (functions for deterioration of building materials)	Must	100%	100%	
FR_12	Function compatibility (functions for deterioration of building materials)	Must	100%	100%	
FR_13	Function Dependency on Orientation (functions for deterioration of building materials)	Should	50%	50%	These functions require site-specific and material-specific calibration; therefore, it is not possible to obtain a generalized equation. Specific laboratory and outdoor experimental procedures have been designed to evaluate the deviation of the recession rate based on building orientation. The partial commitment refers to the fact that, due to this limitation, such functions were not fully integrated into the HRAP Platform
FR_14	Simulator output compatibility (HT Simulator)	Must	100%	100%	
FR_15	Simulator Scenario (HT Simulator)	Could	100%	100%	
FR_16	HT Simulator online availability (HT Simulator)	Must	70%	100%	
FR_17	Assessment of building material deterioration (HT Simulator)	Could	70%	100%	
FR_18	Multi-hazard Model compatibility (Multi-hazard Model)	Must	100%	100%	
FR_19	Multi-hazard Model Spatial Resolution (Multi-hazard Model)	Must	100%	100%	
FR_20	Multi-hazard Model output integration with atmospheric models (Multi-hazard Model)	Must	75%	100%	
FR_21	Simulator Scenario (SG Simulator)	Could	75%	100%	The structures can be modeled based on the double-modified multiple vertical line element model and the Unified method

					using the GUI. Calculators for deriving the mechanical properties are provided to minimize the modeling time. Furthermore, the ability to perform various analysis types including incremental dynamic analysis is facilitated.
FR_22	SG Simulator online availability (SG Simulator)	Must	100%	100%	https://www.softxjournal.com/article/S2352-7110(22)00148-0/fulltext
FR_23	Download material properties data (Vulnerability Modules)	Should	100%	100%	The uploaded vulnerability data can be downloaded (after authorisation) through the Middleware REST API in json format.
FR_24	VM transient measured data (Vulnerability Modules)	Should	100%	100%	Same as FR_23.
FR_25	VM Hazard Models Input (Vulnerability Modules)	Should	100%	100%	Only standard formats supported (netCDF, hdf5, json).
FR_26	VM Raw Climate data (Vulnerability Modules)	Should	100%	100%	Only standard formats supported (netCDF, hdf5, json).
FR_27	VM 3D images and documentations (Vulnerability Modules)	Could	75%	100%	BIM models of the structures have been included to HRAP where available.
FR_28	VM Weather Stations data input (Vulnerability Modules)	Should	100%	100%	
FR_29	VM 3D scanned file input (Vulnerability Modules)	Should	100%	100%	The 3D-scanned files were converted from (.obj) and (.ply) format to (.nxs) and (.nxz) to integrate them to the HRAP Platform.
FR_30	VM Local Processing (Vulnerability Modules)	Should	50%	100%	For security reasons, the user needs to communicate all new files to the Middleware via secure authentication. The reports of WP5 describe the relevant file structures.
FR_31	Resilience Assessment Framework compatibility (Resilience Assessment Framework)	Should	95%	100%	
FR_32	Resilience Assessment Framework compatibility (Resilience Assessment Framework)	Should	75%	100%	Data from more pilot sites were added in V2.
FR_33	Resilience Assessment Framework compatibility (Resilience Assessment Framework)	Must	75%	100%	Block by block resolution achieved (min 100m*100m).
FR_34	Socioeconomic Resilience engine data harvesting (Socioeconomic Resilience Engine)	Should	80%	100%	In V1 data were collected for Rhodes, Tonsberg, and Granada. In V2 also for Venice.
FR_35	Create a socioeconomic model for users, local economy and small businesses (Socioeconomic Resilience Engine)	Should	80%	100%	In V1 the socioeconomic models of Rhodes, Tonsberg, and Granada were realized. V2 includes Venice with flood hazard.
FR_36	Socioeconomic Resilience Engine compatibility (Socioeconomic Resilience Engine)	Should	90%	100%	The output of the engine comprises a set of .png images and .json files, whose format has been standardized from V1.

FR_37	Socioeconomic Resilience Engine output (Socioeconomic Resilience Engine)	Should	80%	100%	From the first version (V1), HRAP can provide the user with the socioeconomic impact results for a given hazard and intensity .
FR_38	The UAS is necessary for each Tier 1 building/site in order to immediately acquire the appropriate data for the 3D documentation in case of an event or in a routine monitoring context (UAS)	Must	100%	100%	The UAS have been set and used in all Tier 1 buildings/sites in order to acquire digital images (RGB and Hyperspectral) except from the Granada Tier 1 Building due to flight restrictrions. Other methods were implemented to acquire the necessary data.
FR_39	The UAS raw data (digital images) could be uploaded in HRAP in order to make them available to all the users in case of an event or in a routine monitoring (UAS)	Could	100%	100%	This functionality is implemented by Middleware. The uploaded raw data files (images) can be downloaded through the REST API.
FR_40	In a routine monitoring context, each Tier 1 building/site will be 3D documented and reference 3D models will be created. A methodology will be developed for the estimation of the deformations in a regular monitoring framework. A similar methodology will be developed for the estimation of changes in building materials from hyperspectral imagery (Monitoring capabilities)	Must	100%	100%	During the project's lifetime all Tier 1 buildings/sites were 3D documented and added to the HRAP Platform. These 3D models will be used as reference models in the future. The methodology to reference, compare 3D models, and estimate changes/deformations/material loss has been developed and already implemented in certain Tier 1 buildings.
FR_41	Establishment of a standard monitoring procedure including selection, downloading, pre-processing, and processing of satellite images for Tier 3 information on Hyperion areas in order to regurarly estimate land deformation and land use changes in these areas (Monitoring capabilities)	Must	100%	100%	The monitoring procedure for deformation maps will take place every 1.5 year and for the land use changes every 5 years.
FR_42	After the acquisition process of the UAS, the data will be processed in the GGS and the accurate, detailed 3D models will be produced and stored in HRAP. Furthermore, satellite remote sensing data will be processed in the GGS which will provide Tier 3 pre- and post-disaster products related to landslide, earthquake or flood events. Hyperspectral imagery information will be processed and analyzed in the GGS to derive information regarding potential damage on sites materials (Damage Assessment)	Must	100%	100%	
FR_43	Keep track of all users' activities (HRAP Platform)	Should	100%	100%	
FR_44	A User-friendly and intelligent user interface to visualize all the user activities (HRAP Platform)	Should	100%	100%	
FR_45	The ability for administrators to manage user access to the HRAP (HRAP Platform)	Should	100%	100%	

FR_46	A policy-neutral access-control mechanism defined around roles and privileges (HRAP Platform)	Should	100%	100%	
FR_47	Provide the ability to the users to perform spatial queries over the data (HRAP Platform)	Should	80%	100%	In V2 the risk assessment data have been included allowing spatial querying over all models.
FR_48	The user interface design will make the user's interaction as simple and efficient as possible, in terms of accomplishing user goals (HRAP Platform)	Should	75%	100%	The UI has been re-designed to a clearer format.
FR_49	Personalized views, according to user roles (HRAP Platform)	Should	80%	100%	Same as FR_48.
FR_50	HRAP Platform Visualization (HRAP Platform)	Should	80%	100%	In V2 all models have been included and the visualization has been refined to serve them.
FR_51	The HRAP Platform will visualize BIM models (HRAP Platform)	Should	100%	100%	
FR_52	DSS will provide assistance to the CH operators during maintenance as well as phases of a crisis incident (mitigation, preparedness, response and recovery) (HRAP Platform)	Should	25%	100%	The DSS provides priority listing of vulnerable buildings before and after a crisis. Only financial mitigation tool are provided.
FR_53	Assessing Business Continuity Models and Adaptation Strategies (HRAP Platform)	Should	80%	100%	
FR_54	Visualization interface will provide assistance to the CH operators during maintenance as well as all phases of a crisis incident (mitigation, preparedness, response and recovery) (HRAP Platform)	Should	100%	100%	
FR_55	Provide weighted mitigation strategies (HRAP Platform)	Could	50%	100%	Four mitigation strategies are provided.
FR_56	The models should provide the needed information to the DSS (Business Continuity Models)	Should	80%	100%	
FR_57	The model output needs to be in compliance with the other models so as to be integrable (Business Continuity Models)	Should	100%	100%	
FR_58	The model output needs to be in compliance with other models so as to be integrable (Business Continuity Models)	Should	100%	100%	
FR_59	The models should provide the needed information to the DSS (Response Actions)	Should	100%	100%	
FR_60	The model output needs to be in compliance with other models so as to be integrable (Response Actions)	Should	100%	100%	

FR_61	Middleware must be able to collect data from various sensors/smart tags in real time (Middleware)	Must	100%	100%	
FR_62	Middleware must be able to collect and store data from various available datasets, i.e. seismological information, or user uploaded (Middleware)	Should	100%	100%	
FR_63	The Middleware should be able to accept, store and retrieve input from HRAP if this is deemed necessary by the HRAP processes. The input should be relevant to open user sessions and model outputs (Middleware)	Should	0%	0%	The Middleware implemented a stateless REST API and this requirement was not implemented. The user permissions are managed by the HRAP platform internally and the Middleware is serving requests only to HRAP authorized sessions requests.
FR_64	Models are updated (offline) based on new input. Thus, results stored in the middleware must also be updated (Middleware)	Should	100%	100%	
FR_65	Middleware must expose an API to enable HRAP access the collected data and the model results (Middleware)	Must	100%	100%	
FR_66	The images collected by the user should include information about the location that they were captured and the time (ICT Tool)	Should	100%	100%	
FR_67	The ICT Tool should allow the creation of new user, manage user profiles and passwords (ICT Tool)	Should	100%	100%	
FR_68	The ICT Tool addresses citizens so it needs to be as engaging as possible (ICT Tool)	Should	80%	100%	To increase the citizens engagement a mobile application was developed. At V1 the first version was implemented. At V2 the final version with additional damage categorization based on ICOMOS and buildings categorization based on TIer-1 is available.
FR_69	The information collected should be available at the HRAP platform (ICT Tool)	Should	80%	100%	All the information (images, description, tags, geolocation and time) is stored and displayed at the HRAP via the PLUGGY API. This includes the web-based ICT tool and the mobile application.

Table 2: Technical Assessment of the Non-Functional Requirements (NFRs).

ID	Description (Category)	Priority	V1 status	V2 status	Remarks (optional if UR is 100% in V2, mandatory if the UR was not fully met)
NFR_1	Data Storage (General)	Must	100%	100%	See D2.2
NFR_2	Keep code versioning (General)	Must	100%	100%	All the code developed by ICCS has been stored at a secure web-based repository - GitLab. All the documentation (presentations, deliverables etc.) have been stored in Redmine work space.

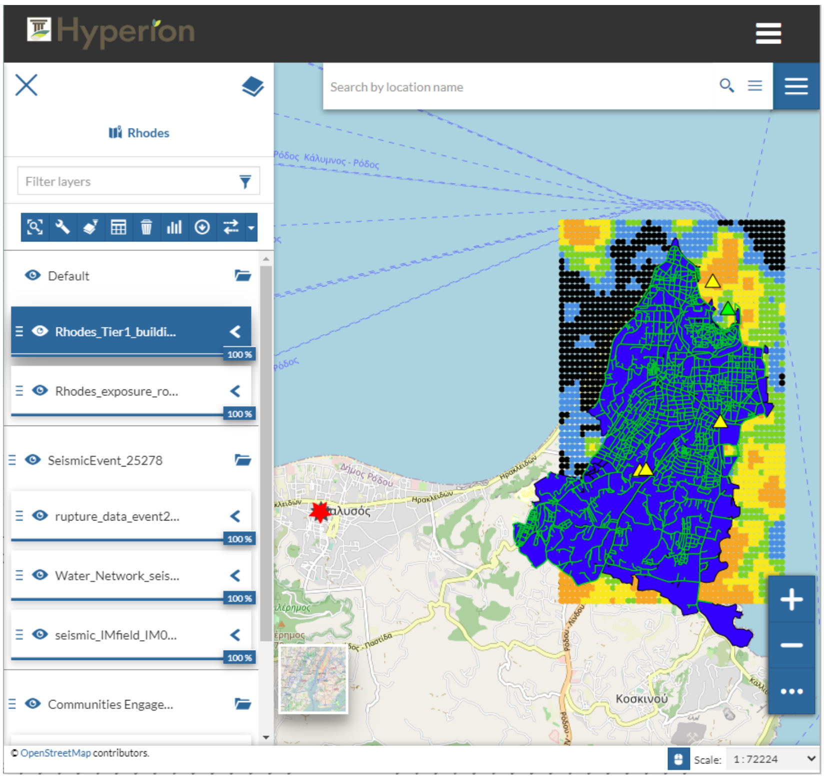
NFR_3	National and EU regulations compliance (General)	Must	100%	100%	1. HRAP does not use/store personal data from the users 2. See D.6 for all legislation/standard compliance
NFR_4	Continuous updated based on the data collected from the micro-climatic stations (Atmospheric Models)	Should	70%	100%	In V1 the data assimilation methodology was implemented using dummy data, while in V2 this module was enhanced in the operational part of the OMS and tested off-line regarding its performance.
NFR_5	Smart Tag Installation (Smart Tags)	Must	100%	100%	All developed sensors (Smart Tags) have been installed non-intrusively using removable tire-ups.
NFR_6	Smart Tag Autonomy (Smart Tags)	Could	100%	100%	Smart Tags were designed respecting the infrastructure limitations. 1. Power: cable / solar panel. 2. Network: NB-IoT / WiFi. The Smart Tags have been operated for approximately 16 months (M32- M48) with some actions taken (repositioning, resetting, battery changing) to achieve this period of operation.
NFR_7	Simulator input climate data (HT Simulator)	Must	80%	100%	
NFR_8	Simulator input material properties (HT Simulator)	Must	100%	100%	
NFR_9	Resilience Assessment Framework model integration (Resilience Assessment Framework)	Should	100%	100%	
NFR_10	Simulator input hazard intensity (SG Simulator)	Must	100%	100%	
NFR_11	Simulator input material properties (SG Simulator)	Must	100%	100%	Hyperomet includes an accurate enough macroelement representing the nonlinear behavior of URM components
NFR_12	Simulator input 3D drawings (SG Simulator)	Must	100%	100%	
NFR_13	Transfer of data such as confidential or proprietary information of a secure channel (HRAP Platform)	Should	100%	100%	HRAP uses SSL to communicate with Middleware and community's engagement tool and APIs
NFR_14	Storage encryption is a technology which protects information by converting it into unreadable code that cannot be deciphered easily by unauthorized people (HRAP Platform)	Should	0%	0%	The cloud hosting can be configured to use encrypted storage. Our tests revealed that the encryption in combination with the large file sizes was causing delays to the User Interface, thus it was disabled. The HYPERION system is currently using encryption only for the users' private information (name, location) and for the user passwords
NFR_15	Object Virtualization Module - A module that is used to virtualize data collected from smart tags and other sensors under a single queryable object (Middleware)	Should	100%	100%	

NFR_16	The Event Queries Manager is set to query and extract possible events from the collected data and model outputs. These events are then passed to the Event Queue for further processing to detect and raise complex alerts (Middleware/ Event Queries Manager)	Should	100%	100%	
NFR_17	The Event Handling Manager processes identified events, by applying pre-set event handling and reasoning rules. The Manager also applies Complex Event Processing (CEP) to identify potential actions stemming from multiple events and not just single units (Middleware/ Event Queries Manager)	Should	100%	100%	
NFR_18	Alert Module - A module that is used to raise and log alerts based on model outputs and smart tags/sensors collected data (Middleware)	Should	0%	100%	
NFR_19	Projection Timeframe (HRAP Platform)	Should	100%	100%	Minimum projection is 80 years
NFR_20	Types of materials characterized (General)	Must	100%	100%	List of materials: Monzonite, Latite (Tønsberg); Macael Marble, Santa Pudia Limestone (Granada); Sfouggaria Stone, Lartios Stone (Rhodes); Botticino Limestone, Carrara marble, Red Verona Limestone, Costozza Stone, Trachyte, Istrian Stone (Venice); bricks (Venice); rammed earth (Granada), wood (Tønsberg). Properties: Petrography, mechanical properties, porosity, colour, bulk and matrix density, hydric properties, thermal properties, ultrasound wave velocity, resistance to salt crystallization, resistance to freeze-thaw cycles.
NFR_21	Types of smart tag sensors (Smart Tags)	Must	100%	100%	Plus a sensor to assist in the categorization of the wall's surface to wet or dry state.

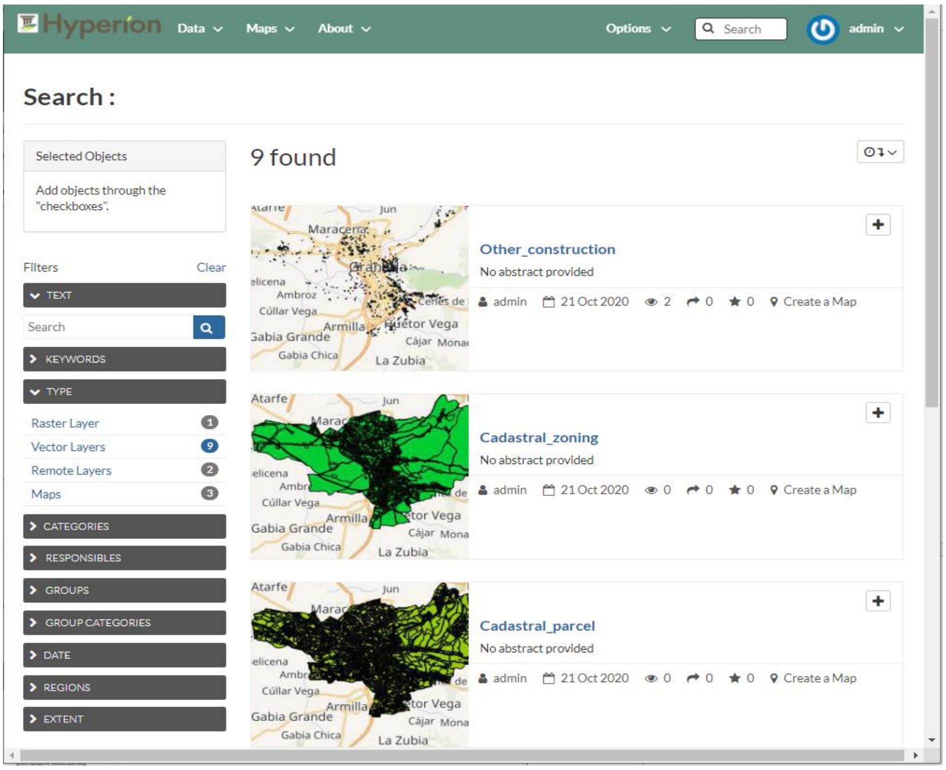
3 Operational Assessment

Comprehensive operational assessments have been conducted from the release of V1 (M29) up to the end of the project (M48) to assess whether the HYPERION system meets its intended goals and objectives. During the 1st testing period (M29-M34), the assessment mainly included virtual pilots and trials as the COVID-19 restrictions did not allow the implementation of physical events. Nevertheless, the technical partners collaborated closely with the end-users for the realization of a user-friendly system, fixing issues and adding features according to the feedback taken from the latter. During the 2nd testing period (M37-M44) the implementation of physical pilots was possible, which accelerated considerably the improvement of the system. The physical pilots (see Figure 2) were conducted in the context of plenary meetings so as the majority of the Consortium was present and the relevant end-user was available for the demonstration. More information about the pilots can be found in Deliverable 8.6.

Following the 2nd testing period, version V2 of the system was deployed in M44. Apart from the technical components that were refined and fixed in V2, the User Interface (UI) of HRAP was also re-designed to a clearer format. These changes were made after thorough discussions with the end-users and the technical partners to realize a UI that is user-friendly and intuitive. For instance, modifications were made in the visualization dashboard (e.g., legends, fonts, layers), the presentation and reporting of sensor data (time-history diagrams, bar charts and filtering), the graphical illustration of the results from Socioeconomic Engine, etc. Figure 3 shows two screenshots for the re-designed UI of HRAP.



(a)



(b)

Figure 3: Screenshots from the re-designed UI of HRAP, showing (a) the GIS-mapping client for multi-layer interactive maps and (b) the visualization dashboard and advanced searching features.

Finally, from M37 up to M48 a series of training sessions was conducted with the end-users to familiarize them with the system, address their feedback, and fix minor issues. A total of four training sessions were organized within the context of the four pilot demos. In each session, the pertinent customization of the HYPERION system was employed in terms of hazards (e.g., flood for Venice, earthquake for Granada), assets (e.g., site-specific tier-1 structures per site), and models (e.g., socioeconomic model that depicts city's local economy).

Feedback was collected by integrating the User Experience Questionnaire (UEQ) (Deliverable 8.3) into HRAP and requesting the end-users to provide their answers at the end of each training session. The structure of the questionnaire is given in Annex A. It consists of 26 questions that are answered by a rating score between 0 to 10 and are related to the user's experience with the platform.

A total of 149 individuals were invited to answer the UEQ during the four pilot events (Granada 69, Venice 63, Tonsberg 8, Rhodes 9). About 30% of them (46 individuals) responded and their feedback was collected and analyzed by the technical partners. The distribution of responders among the four pilot sites is depicted in Figure 4. For assessment purposes, the rating score was transformed from the scale [0, 10] to the scale [-3, 3], where -3 and 3 indicate bad and excellent performance of the platform, respectively. The mean value of the rating score per question is illustrated in Figure 5.

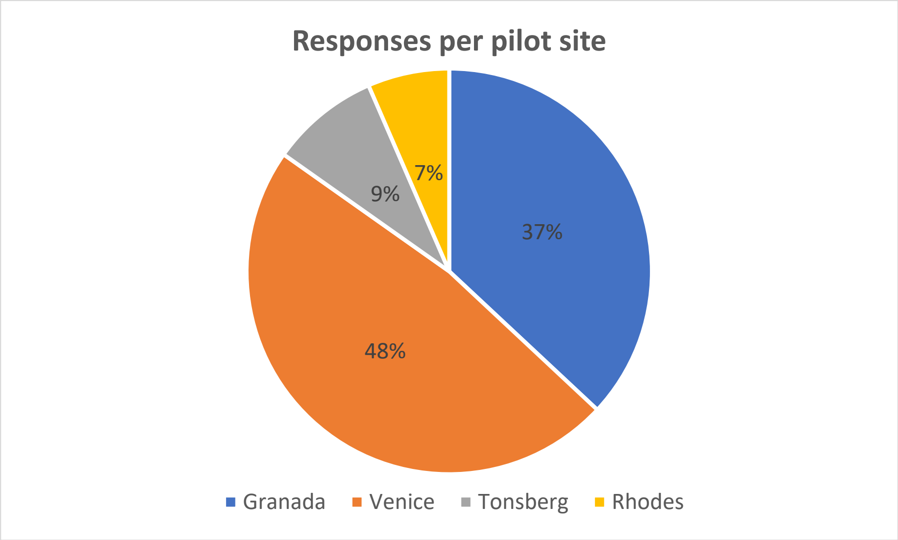


Figure 4: Responses to the UEQ per pilot site

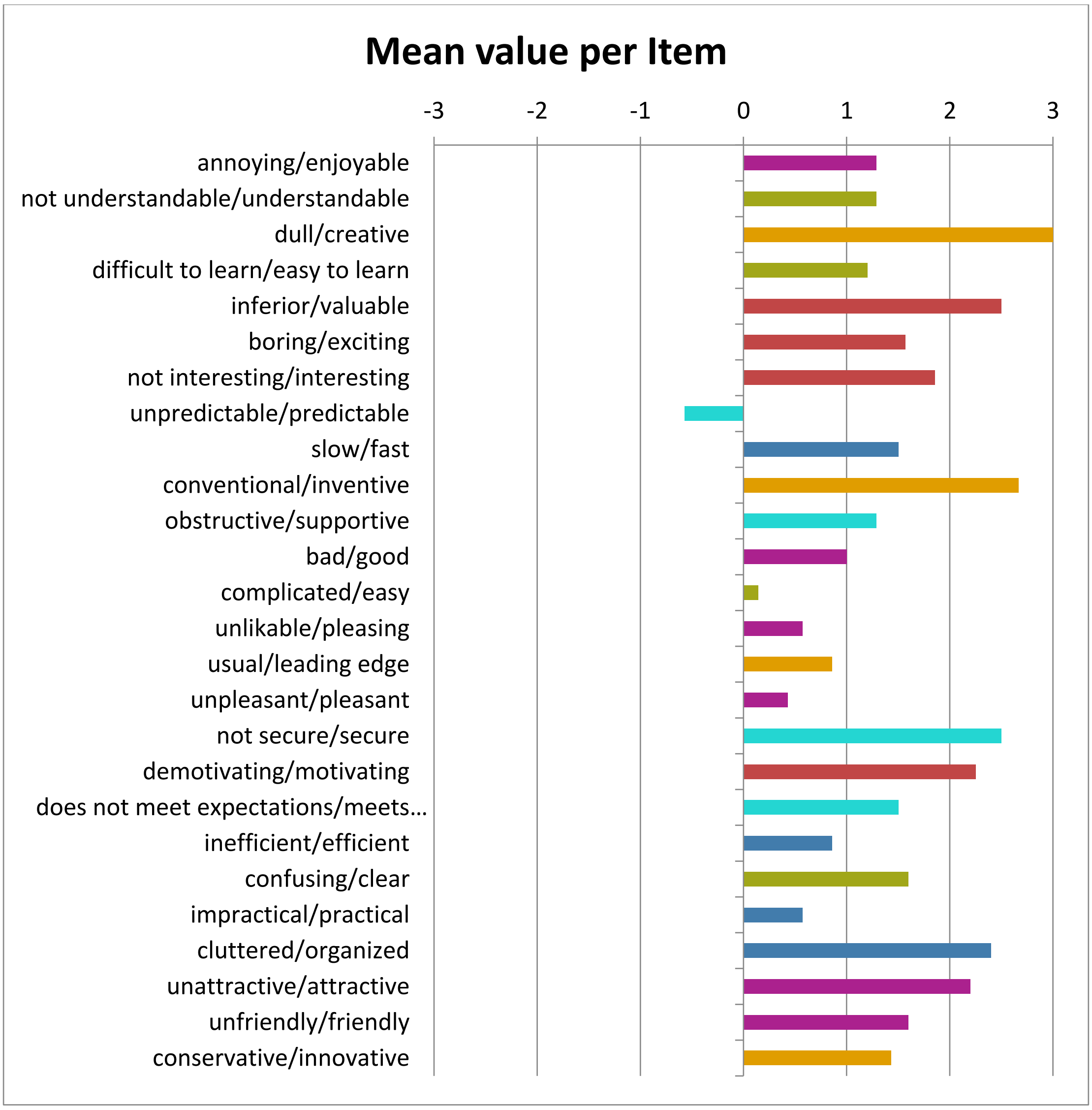


Figure 5: Mean value of rating score per question (26 questions)

Scale	Mean	Comparisson to benchmark
Attractiveness	1.29	Above average
Perspicuity	1.25	Below Average
Efficiency	1.42	Above Average
Dependability	1.11	Below Average
Stimulation	2.06	Excellent
Novelty	1.63	Excellent

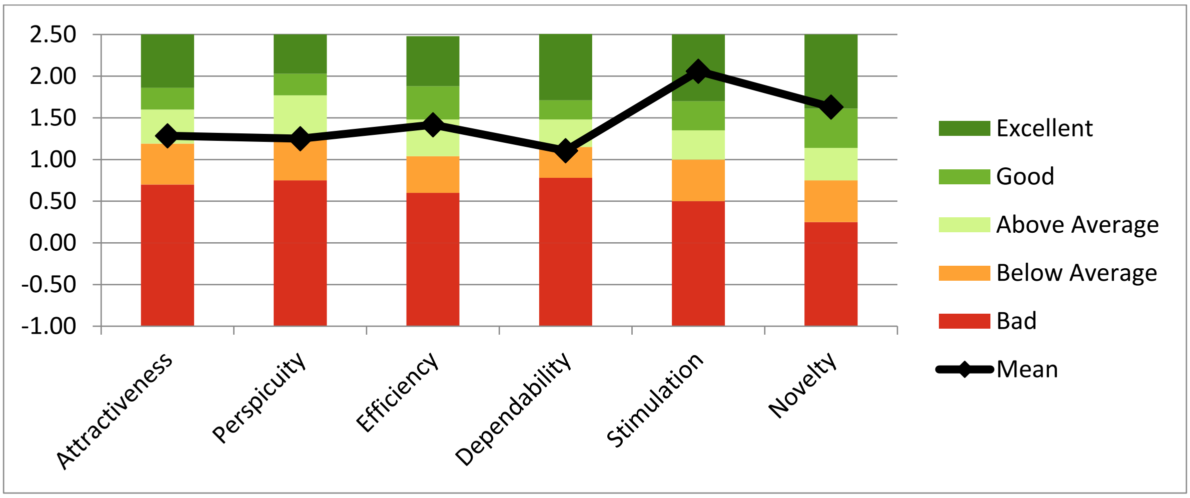


Figure 6: Rating score per question category (6 categories)

The questionnaire provides a comprehensive impression of the user experience; both classical usability aspects (efficiency, perspicuity, dependability) and user experience aspects (originality, stimulation, attractiveness) are measured:

- Attractiveness: Overall impression of the product. Do users like or dislike the product?
- Perspicuity (Clarity): Is it easy to get familiar with the product? Is it easy to learn how to use it?
- Efficiency: Can users solve their tasks / navigate without unnecessary effort?
- Dependability: Does the user feel in control of the interaction?
- Stimulation: Is it exciting and motivating to use the product?
- Novelty: Is the product innovative and creative? Does it catch the interest of users?

For each category, a final score between -3 and 3 was calculated based on the rating scores of the participants. The range of the scales is between -3 (horribly bad) and 3 (extremely good). Figure 6 illustrates bar charts with the mean values and dispersions of the results as well as the final score of each category. Overall, the scores are average or above average for most categories, *showcasing an excellent performance in the Stimulations and Novelty categories*. This outcome is very promising for the future of HYPERION as it indicates that our platform fills a gap in the market of civil & CH protection by offering novel tools and methodologies that are missing from existing solutions.

The relative low Perspicuity and Dependability scores are mainly attributed to the extensive set of available features, which made the platform somewhat complicated for non-expert users. To improve the user experience in terms of both, the technical partners agreed that a comprehensive documentation/user guide would be useful, as well as an integrated helpdesk. The integration of helpdesk functionality is considered necessary before the deployment of the platform as outlined in the Exploitation Roadmap to achieve TRL9 (see Deliverable 10.5).

4 Recommendations

Apart from the operational assessment during the pilot activities and at the end of each training session, the end-users also provided several recommendations to enhance the usability and performance of the HYPERION system through face-to-face conversations. Approximately 15-20 end users provided their feedback verbally mainly to RG and technical partners (RISA and CYRIC). It is noted that the end-users who provided recommendations verbally had not necessarily completed the UEQ. Their recommendations reflect real-world scenarios and challenges and, thus, should be taken into great consideration by the technical partners aiming to commercialize their results. Moreover, end-users offer valuable insights into their evolving needs and expectations. As technology and URs change over time, their recommendations can assist in keeping the system up to date with emerging trends and user demands. The specific suggestions of the pilot partners are depicted in Table 3.

Table 3: Recommendations for future improvements

• In the priority lists, add a legend that explains the different colors (e.g., the values of the annual indirect losses). • In the assessment of the water network, perhaps explain what Mean Annual Frequency (MAF) means or use another metric that can be understood by non-technical users. • The socioeconomic results show 3 outputs: (i) the loss of GVA for the most critical sector, (ii) the total loss of GVA of the city, and (iii) the effect of the event on tourism. In a future release of the platform, it will be good to show the monetary losses of any sector that the user requests. This can be done by making the socioeconomic graph interactive so by clicking on a sector the gifs and images are updated. • Add a capability to export the 3D models of the Tier-1 buildings to a CAD format. Also, a feature that can measure distances and angles will be useful.
• Modify the position of the triangles in the maps to point to the exact location of the Tier1 structures in Tønsberg (HeierstadLoft and Bentegarden are not precise, FadumStore is ok). • Colourscale of the 3D model in Tønsberg is not so clear regarding the expected changes over time. The shaded model falsifies the colours. Additionally, a continuous colourscale as basis for administrative decisions is difficult. A scale with an x number of discrete classes would be more helpful. • The entire platform needs a sort of help-site/glossary to describe and explain. At the moment, many of the functions are confusing to non-experts. This applies in particular to the multi-hazard assessment page. • Multi-hazard assessment (Tønsberg): different data sets (wind/rain/temperature, etc.) are only accessible through a small box in the upper left corner of the map. This is easy to overlook/difficult to find. • The maps showing various weather phenomena in the short-term and long-term planning function (Weather) should be made transparent so you can read the underlaying terrain map.
• Being able to export a report of the search after it is used. • Add a description for the different CC scenarios in HRAP to be easily understood by non-experts. • In the socioeconomic model, when the losses are below 0.01 million € then display the results in thousands €.

5 Conclusions

Deliverable D8.7 reported a series of technical and operational assessments conducted in the two versions (V1 and V2) of the HYPERION system. In V1 (M29), a large spectrum of technical components was combined to deliver the first realization of the integrated platform. Two testing periods followed the deployment of V1 (M29-M34 and M37-M44), in which the platform was assessed and upgraded by the technical partners and the end-users. The final version of the system (V2) was deployed in M44, followed by a series of training & testing sessions until the end of the project.

The technical and operational assessments reported in this document showcase that V2 achieves the desired behavior in terms of performance, accuracy, integrity, and user experience. Our extensive technical assessments show the complete alignment of the system with the initial functional (FR) and non-functional (NFR) requirements, while the operational assessments indicate that the platform meets the end-users' expectations. Finally, the deliverable presents several recommendations to improve the efficiency of the platform, which were collected by the pilot partners during the training and pilot activities.

Annex A – Structure of the HYPERION Platform Questionnaire

Hyperion Platform Questionnaire

* Απαιτούνται

1. Name *

Εισαγάγετε την απάντησή σας

2. Email Address *

Εισαγάγετε την απάντησή σας

3. *

0	1	2	3	4	5	6	7	8	9	10

Annoying — Enjoyable

4. *

0	1	2	3	4	5	6	7	8	9	10

Not Understandable — Understandable

5. *

0	1	2	3	4	5	6	7	8	9	10

creative — dull

6. *

0	1	2	3	4	5	6	7	8	9	10

Easy to learn — Difficult to learn

7. *

0	1	2	3	4	5	6	7	8	9	10

Valuable — Inferior

8. *

0	1	2	3	4	5	6	7	8	9	10

Boring — Exciting

9. *

0	1	2	3	4	5	6	7	8	9	10

Not Interesting — Interesting

10. *

0	1	2	3	4	5	6	7	8	9	10

Unpredictable — Predictable

11. *

0	1	2	3	4	5	6	7	8	9	10

Fast — Slow

12. *

0	1	2	3	4	5	6	7	8	9	10

Inventive — Conventional

13. *

0	1	2	3	4	5	6	7	8	9	10

Obstructive — Supportive

14. *

0	1	2	3	4	5	6	7	8	9	10

Good — Bad

15. *

0	1	2	3	4	5	6	7	8	9	10

Complicated — Easy

16. *

0	1	2	3	4	5	6	7	8	9	10

Unlikable Pleasing

17. *

0	1	2	3	4	5	6	7	8	9	10

Usual Leading Edge

18. *

0	1	2	3	4	5	6	7	8	9	10

Unpleasant Pleasant

19. *

0	1	2	3	4	5	6	7	8	9	10

Secure Not Secure

20. *

0	1	2	3	4	5	6	7	8	9	10

Motivating Demotivating

21. *

0	1	2	3	4	5	6	7	8	9	10

Meets Expectations Does not meet expect ations

22. *

0	1	2	3	4	5	6	7	8	9	10

Inefficient Efficient

23. *

0	1	2	3	4	5	6	7	8	9	10

Clear — Confusing

24. *

0	1	2	3	4	5	6	7	8	9	10

Impractical — Practical

25. *

0	1	2	3	4	5	6	7	8	9	10

Organized — Cluttered

26. *

0	1	2	3	4	5	6	7	8	9	10

Attractive — Unattractive

27. *

0	1	2	3	4	5	6	7	8	9	10

Friendly — Unfriendly

28. *

0	1	2	3	4	5	6	7	8	9	10

Conservative — Innovative

29. Please provide any additional feedback below:

Εισαγάγετε την απάντησή σας

30. *

☐ I understand and agree that my data will only be used by Hyperion Consortium for product improvement purposes, and will not be distributed to any third party for promotional purposes

31.

☐ I'd like to receive updates about the Hyperion project by email

Υποβολή

Ποτέ μην αποκαλύπτετε τον κωδικό πρόσβασής σας. Αναφορά κακής χρήσης