xR4DRAMA

Extended Reality For DisasteR management And Media planning
H2020-952133

D6.2
Final user requirements

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Abstract
This deliverable describes the prioritised and refined user requirements regarding the two pilot use cases. It also contains further specifications of the use cases themselves.

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History

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Executive Summary

Based on D6.1 and further feedback and discussions within the consortium, this deliverable further specifies the two use case scenarios. It describes specific locations that were chosen for now to showcase and test the first prototype. The deliverable also restructures and refines the user requirements by differentiating between *system-related* and *information-related* requirements. These refined requirements were based on the initial user requirements but were considerably extended in thorough discussions between technical partners and user partners. An additional focus was laid on the specific information that users are interested in. We identified potential sources for this information as well as the methodology on how to gather that information and analyse it. Finally, the appendices show new and more elaborated mock-ups of possible visual representations regarding the three different levels of situation awareness.

Abbreviations and Acronyms

AR	**Augmented Reality** is an immersive technology superimposing layers of digital content into the physical world to enhance the user's real-world experience
DoA	**Description of Action**
DP	**Disaster Preparedness** measures taken to prepare for and reduce the effects of disasters. That is, to predict and, where possible, prevent disasters, mitigate their impact on vulnerable populations, and respond to and effectively cope with their consequences
DRR	**Disaster Risk Reduction** aims to reduce the damage caused by natural hazards like earth-quakes, floods, droughts and cyclones, through an ethic of prevention
MR	**Mixed reality** is a hybrid definition combining both AR and VR
SA	**Situation Awareness**
XR	**Extended Reality** also known as cross-reality and hyper-reality, is an umbrella term that encompasses human-machine interactions generated by computer technology with devices or wearables to create real and virtual environments which include VR and AR

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1 INTRODUCTION

This deliverable describes the - at this point - final user requirements regarding the two use cases disaster management and media production planning. Based on the initial user requirements as described in D6.1, we have now further refined and updated the requirements and agreed on a list of priorities within the consortium. We have also further specified the use cases themselves in order to establish a clear framework for the development of the xR4DRAMA platform and its functionalities. Of course, given the uncertainties that are caused by the COVID pandemic as well as possible deviations in the development process, these specified use case scenarios are up to revision at any time. However, any revisions will be carried out with the clear purpose of providing realistic near-real-life scenarios that can serve as proof of concept when evaluating the xR4DRAMA results.

This deliverable starts with a short summary of what we have already established in D6.1. This refers especially to the underlying concept of *situation awareness* and the project's approach to strive for three sequential levels of situation awareness (Section 2). Section 3 delivers an update on the disaster management use case and Section 3.2.2 the same regarding the media production planning use case scenario. The core of this deliverable is the presentation of the refined (and final) user requirements in Section 5. This section also contains some reflections on how to visualise the three levels of situation awareness (see 5.4) and how to design the user interface (see 5.5). Section 6 contains a short outlook on further work in WP6. The deliverable ends with a short summary and the main conclusions in Section 7.

2 INITIAL USER REQUIREMENTS AND SITUATION AWARENESS

2.1 General background

In D6.1 we have already described the user requirements in great detail. This deliverable will contain a further refinement of these requirements based on further specifications of the two use cases. The leading theoretical concept behind this project is still the establishment of "situation awareness". We will not repeat everything that was said in the proposal or in D6.1, but will nevertheless provide a short summary of how we understand and specify this underlying concept. *Situation awareness* describes how humans perceive the elements of a given environment within spatial and temporal confinements and how that perception affects their performance and decision-making in the situation at hand. Designing for situation awareness has become particularly important where decision-making happens under time pressure, remotely or among multiple operators. Although COVID did not exist when we wrote the xR4DRAMA proposal, the pandemic with all its travel and contact restrictions has unveiled an even stronger need for remote planning of events, be it a natural disaster or a (media) production in a remote location. At Deutsche Welle, for instance, many planned productions had to be cancelled or had to be organised remotely and in a very improvised manner.

The methods and tools by which situation awareness can be created, enhanced and maintained are manifold. Situation awareness can be established simply by bringing together different information about a location such as geographical data, sociographic information, cultural context, images, videos and the like. It can be further enhanced by creating, for instance, a three-dimensional visualisation of topographical data (e.g., in the form of Augmented Reality). And finally, as a more elaborate approach, situation awareness can be accomplished by developing a sophisticated and more complex and comprehensive virtual representation of a specific location (Virtual Reality). In xR4DRAMA, we intend to utilise simple two-dimensional visualisations for desktops or handhelds as well as XR features or advanced VR technology in order to create a highly immersive environment.

2.2 Three Levels of situation awareness

The underlying approach within xR4DRAMA is to create and enhance *situation awareness* for those who are - remotely as well as directly - involved in the planning of and the dealing with events and incidents in a specific location. We have decided to focus on *three levels of situation awareness* that will build on each other. This approach does not only allow us to follow a linear, step-by-step development process, but will also enable us to evaluate which levels of situation awareness are indeed the most suitable in a specific scenario.
The three levels that we have defined in D6.1 (Section 2.2) are

- **Level 1 situation awareness:** An appealing, easy-to-digest representation and visualisation of different content and information about a location such as geographical data, sociographic information, cultural context, images, videos and the like. It is important to state that all data that is presented at this point is expected to be generated automatically by the system.

- **Level 2 situation awareness:** An enhanced representation and visualisation that especially builds on recent content and information stemming from people in the field (first responders or location scouts) who will use various tools and sensors in order to capture data that is most relevant to the individual use case scenario. We imagine the system to process this data "from the field" and to combine it with the data about the location that was already gathered remotely from accessible web- and cloud services. This representation could be available to remote management in a distant control room as well as to staff in the field.

- **Level 3 situation awareness:** This level stands for a more sophisticated and more complex and comprehensive virtual representation of a specific location, close to a simulation of an event within that environment. Here, users imagine the deployment of rather mature VR, AR or XR representations that can be perceived by sophisticated tools, such as VR/XR head mounted displays (VR HMD) or enhanced sound systems and that contribute to a higher level of (relevant) immersion and thus better situation awareness. The main difference to the Level 2 situation awareness is the fact that here user will be able *to interactively test specific strategies and methods*, e.g., to simulate various possible camera movements (in the media production use case). Again, these functionalities could - in gradations - be accessible to remote personnel as well as to people on location.

3 UPDATE ON THE DISASTER MANAGEMENT USE CASE

3.1 Short review of the characteristics of disaster management

In D6.1 (Section 4), we have described the characteristics of disaster management in great detail. Disaster management is a complex process that requires prompt response and coordination between first responders and authorities. It utilises a wide variety of technologies and tools to assist disaster response planners, rescue teams and first responders during an emergency, in situations where getting accurate information about the scope, extent, and impact of the disaster is critical to create and orchestrate an effective disaster response and recovery effort.

The situation awareness that we intend to create within the xR4DRAMA project specifically aims for supporting disaster managers working from a remote position and first responders in the field, to prevent a negative impact on the formulation of an effective emergency response plan due to the lack of awareness about the extent and entity of the emergency and the condition in situ.

3.2 Planning a specific disaster management scenario

In the current deliverable, following discussions with the technical partners, an update of the use cases presented in D6.1 is proposed, reformulating them to make them more consistent with the different phases that characterise the disaster management process (pre-emergency, emergency) and to map them more easily to the different levels of situation awareness identified.
In fact, the operational phases during a disaster management scenario are essentially two. The first phase consists in preparing for the emergency (the control room needs to be alerted on the expected effects of the event to better manage the situation, plan interventions, and verify the procedures of the civil protection plans). In the second phase (just before and during the emergency) the control room needs to display information from the territory such as the localisation of any request of people in danger and any criticalities that can occur and to activate a bilateral exchange of information with the first responders in the field to manage civil protection interventions effectively and efficiently.
The xR4DRAMA platform is supposed to support and facilitate all these activities by the disaster managers in the control room and the first responders in the field. In the following sections we will describe these phases in a more detailed way, imagining how the xR4DRAMA platform could work in a specific *flood risk management* scenario in Vicenza.

3.2.1 UC_1 Pre-emergency management

During the pre-emergency phase (the timing of which ranges from about 48 hours before the emergency to 1 hour from the occurrence of the calamitous event), it is essential that the control room reaches a level of situation awareness so as to better plan the actions of risk mitigation to be implemented in the territory.

The pre-emergency phase starts with the reception of official warning messages by the municipality of Vicenza, dealing with the worsening of safety conditions along the Bacchiglione river (prediction through early warning system of exceeding pre-established alert thresholds for river levels in sections of interest). After that the mayor activates the structure for the emergency management.

The mayor of the City is the primary civil protection authority within his/her municipality and thus responsible for planning rescue operations and coordinating the Municipal Operational Center (COC). Within the COC the mayor uses all the municipal structures to realise the risk mitigation strategies and the operations are coordinated by the Civil Protection Department that uses officials and volunteers.

The municipality needs to verify the civil protection procedures codified in the Risk Management Plan of the City, which are activated on the basis of the expected exceeding of thresholds on river levels.

We imagine the xR4DRAMA to carry out an initial automated query on the expected flooding scenario in Vicenza. This should happen by indexing information about Vicenza and flooding related situations from openly available web- and cloud-sources as well as from a predefined set of proprietary repositories. The results of this query should be analysed, organised and presented in a user-friendly way. This could include, for instance:

- information about the geography of the location (with particular reference to rivers, water courses, riverbanks);
- information derived by satellite images analysis (e.g., land use change, past flood events' extent);
- information about the infrastructures potentially affected by the flood event (including roads, railroads, manholes, electrical and gas pipes);
- Information on the presence of areas of attention, safe waiting/parking places, shelters, sand-bag distribution areas;
- Information on the potential extent of the flood (raster data of flow velocity and water depth in flood scenarios);
- Information on flood risk level in the territory (flood risk maps);
- Information on environmental variables: water levels (current and expected) in the river;
- Information available on radar meteo;
- Information on population potentially in danger;
- Information on cultural heritage/natural sites potentially in danger;
- Information on the codified Civil Protection Plan procedures: localisation, action (e.g. warn the residential building A regarding the situation and ensure the availability of sandbags) and related activation threshold. The control room should be able to visualise the actions to be performed since the activation threshold is exceeded by the forecasted river level.

Ideally, the way of presenting the information should create a Level 1 situation awareness. The main characteristic of this first step is that all information and content derive from an automated query and analysis process.

We imagine that the staff in the control room should be able to visualise the 3D reconstruction using multiple VR devices inside a single environment. (e.g., Oculus rift).

3.2.2 UC_2 Emergency: Information update by First Responders

During the emergency phase (the timing of which ranges from about 1 hour before the emergency to the end of the calamitous event), it is essential that the control room be able to update its situation awareness context by verifying whether the real/current in situ conditions coincide with the forecast of the expected event.
At this stage it is essential to collect data from the territory, both thanks to the help of first responders in the field and thanks to citizens who can report flooding emergencies and critical situations in the territory, elements that must be considered in planning intervention actions.

We imagine the xR4DRAMA will provide the control room to access a more complex level of situation awareness, updating the informative layers already available with information from the field, that may include, for instance:

- Information about flood reports localised by audio analysis and categorised according to the problem issue;
- Information on flooded elements (e.g., cars and people inside the river);
- Information about river embankments overtopping or breaking;
- Information on the presence of elements at risk and the degree of emergency;
- Information about flooding emergencies by drones;
- Information about infrastructures affected by the flood event;
- Information on the real extent of the flood.

These new informative layers should be the result of tools such as visual analysis, text and audio analysis and they should be organised and presented in a user-friendly way, using appropriate filtering systems to ensure that too complex contents cannot affect the clarity of the information framework.

We imagine that the input to these analysis modules will be provided by first responders and citizens who will be equipped by xR4DRAMA with 2 distinct mobile apps for sending text, images, videos.

In particular, the **mobile app for citizens** should allow them to send messages (audio, video, images) to report critical issues (e.g., river overtopping, flood emergencies) and at the same time display useful information from the control room, such as alerts, risk zone warnings about areas at risk, position of safe areas, sand-bag distribution, shelters, etc.).

The **mobile app for first responders** should be able to receive the tasks assigned by the control room and the indications from the operations room, to send information (voice messages, images, videos) in order to update the system and the status of the emergency. The mobile app should allow first responders to send their physiological parameters (for the stress level detection) and also the environmental parameter related to the sensors they are equipped with (e.g., water pressure).

The control room will assign tasks to the first responders in the field with specific requests to update the status of the emergency in particular locations and the first responders need to be able to transmit useful information and check the information provided by the control room. Therefore, it is essential that the xR4DRAMA system guarantee a bilateral exchange.

3.2.3 UC_3 Emergency management on the basis of Situation awareness

During the emergency phase (the timing of which ranges from about 1 hour before the emergency to the end of the calamitous event), decision makers and first responders face a stressful scenario. It is important for the control room to monitor the status of first responders, in order to better assign tasks during the emergency.
We imagine the xR4DRAMA system as capable of providing first responders with important information and reproducing in real time the actual event inside the control room to allow for well-informed and efficient decision making and mitigation actions planning.
The xR4DRAMA system should also show first responders how to act safe and efficiently during an emergency, based on the available information.

This use case will focus on the implementation of some emergency actions in the field to be performed by first responders (e.g., the rescue of a person from a river/swimming pool, the finding of lost people with drones' support). The control room needs to assign tasks, check the performed action (by physiological-physical parameters – stress detection), and monitor their execution in real time, guiding the first responder to optimise the performance of his/her action (efficiency and effectiveness, duration) and ensure safety conditions (e.g., instability in the water, unawareness of what is under the water surface are the most common causes of accidents).

We imagine xR4DRAMA as a system that provides a two-way communication between the control room and the first responders in the field.

A VR environment should be developed during the real event scenario along with AR technologies to visualise the state of the area and to guide the first responders. Physiological sensors on first responders will add value for decision makers; with this technology they can give tasks to a person based on their actual personal physical status in the stressful situation.

The **mobile app for first responders** should be able to receive the tasks assigned by the control room and the indications from the operations room and it should allow first responders to send their physiological parameters (for the stress level detection) and also

the environmental parameter related to the sensors they are equipped with (e.g., water pressure).

We imagine xR4DRAMA as a system able to analyse these parameters to detect the stress level of the first responders and send them warnings. Moreover, the system should allow the first responders to be guided in the action in situ in safe conditions following indications on the best routes to reach the area of intervention or to avoid dangerous areas/elements (e.g., elements not visible under water). They should be able to identify important information about the intervention to be performed (e.g., building to be secured, person to be rescued).

3.3 Criteria for choosing the specific location

Vicenza, Italy is a municipality that faced severe floods in the past, which involved both rural and urbanised areas. It is a highly populated and urbanised area, with extremely complex drainage and irrigation networks and important economic activities, ecological and cultural assets, characterised by high flood risk.

For the above-mentioned reasons, the municipality of Vicenza has always invested in tools such as alert systems and advanced civil protection plans, also being able to count on a high number of highly qualified civil protection volunteers. It therefore represents a fertile ground for experimenting with new technologies and systems to support the mitigation of flood risk and above all cutting-edge techniques that favour the optimisation of civil protection operations and safeguarding the safety of operators in the field.

4 UPDATE ON THE MEDIA PRODUCTION PLANNING USE CASE

4.1 Short review of the characteristics of media production planning

In D6.1 (Section 5), we have described the characteristics of media production planning in great detail. Media production planning is a complex and very often complicated process. It utilises numerous different approaches, strategies and tools depending on the specific kind of production. Production management, for instance, needs to decide on size and qualification of production staff, the necessary equipment, production schedule, travel arrangements, legal requirements, and many more issues.

The situation awareness that we intend to create within the xR4DRAMA project specifically aims for supporting production managers who have not visited and experienced the production location in person. This lack of awareness about the location and the conditions in situ often complicates their work considerably and might even have negative impact on production quality. Therefore, the xR4DRAMA project will focus on bringing situation awareness to a production management team that is working from a remote position.

4.2 Planning a specific media production: A documentary on Corfu

In D6.1, we have only delivered an abstract description of the media production workflow as a more detailed plan needed to be developed in close cooperation with technical partners. Based on these discussions, we have now decided to choose a documentary on the city and island of Corfu (Greece) to showcase and eventually evaluate the xR4DRAMA platform and its functionalities. It has to be highlighted that the following preliminary exposé of a documentary about Corfu does not mean that DW intends to actually complete the production. The xR4DRAMA project is about situation awareness to facilitate media production *planning*. Our goal is therefore to use this *fictitious plan* of a documentary about Corfu to showcase how the xR4DRAMA platform can in fact support the planning of a media production.

Exposé for a documentary film about Corfu

"The old town of Corfu: 15 Years as a Cultural UNESCO World Heritage Site"

The island of Corfu is located off the Western coast of Greece and Albania at the entrance of the Adriatic Sea. The first references to the island originate from 1300 BC, whilst the first Greek settlement most likely took place during the 8th century BC. Because of its strategic position, Corfu has experienced a rather troubled history. Throughout the centuries, the island was ruled by various powers and often subject to unrest and war. Large fortifications and ancient ruins bear witness to these times. In 2007, the old town of Corfu was added to the UNESCO Cultural World Heritage list.

On the occasion of the 15th anniversary of being a world heritage site, Deutsche Welle is planning a documentary on the town and the island. The intention is to cover the changeful history as well as the life of the islanders today.

Planned Content (preliminary)	• a host presenting a 90-minute program from various locations of the Old Town, the fortress and the island; • one interview with, for instance, an archaeologist, a historian or a resident at each site; • a number of 5-10' long films about the sites and other interesting/relevant topics;
Details of production (preliminary)	• live or live on tape; • 2-3 cameras at each spot including a crane plus a drone;

Table 1: Preliminary sketch of media production on Corfu

This rather preliminary sketch of the planned production is a good example for the very first step in this kind of media production. First comes a rough idea which is then expanded through further research, travelling, the identification of relevant topics, the scouting of suitable locations and interview partners as well as the investigation of legal requirements, travel options and specific filming conditions on the ground - to name just a few. **Figure 1** delivers a quick overview of a typical media production planning workflow:

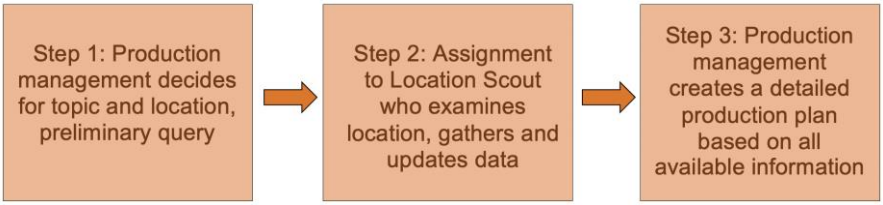

Figure 1: xR4DRAMA media production workflow

Based on this preliminary exposé about the documentary and the described media production workflow, the xR4DRAMA platform is supposed to support and facilitate all these planning activities by the production management team. In the following sections we will describe these three steps in planning the media production on Corfu in a more detailed way. In doing this, we will repeat some of the remarks that have already been made in D6.1. This will allow for better comprehending how we imagine the xR4DRAMA platform to work in the specific *Corfu scenario*.

4.2.1 UC_1 Initial query and preliminary planning regarding the documentary

Based on the rough idea as described before, we imagine the xR4DRAMA to carry out an initial automated query on Corfu. This should happen by crawling and indexing information about Corfu from openly available web- and cloud-sources as well as from a predefined set of proprietary repositories (e.g., EO databases). The results of this query should be analysed, organised and presented in a user-friendly way. With reference to the planned documentary about Corfu this could include, for instance

- images of the fortress in the old town or other sites of interest;
- textual (background) information on the respective sites;
- information about the infrastructure around these sites (accessibility and transport);
- information about the geography of the location;
- environmental factors (e.g., climate, noise pollution).

Ideally, the way of presenting the information should already create a Level 1 situation awareness. The main characteristic of this first step is that all information and content derive from an automated query and analysis process. Figure 2 summarises this process:

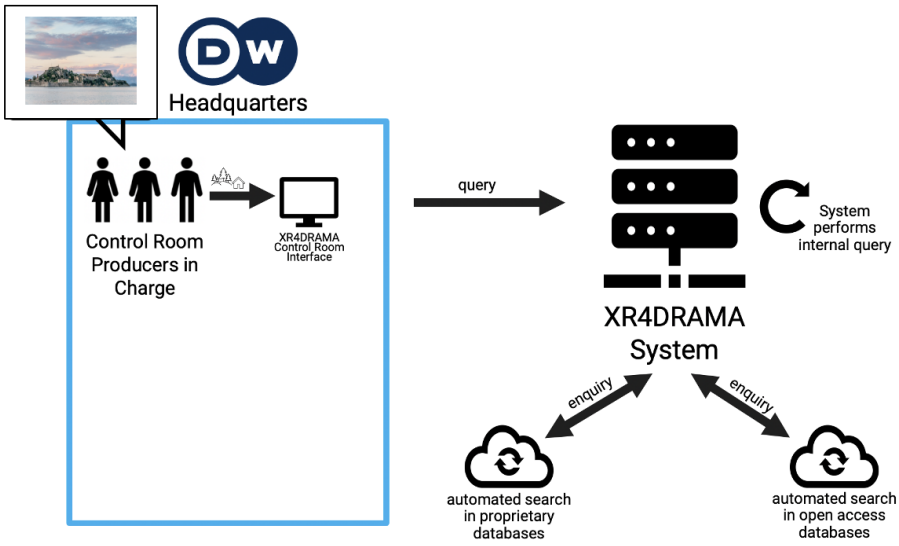

Figure 2: Step 1 of planning the production on Corfu (UC_1)

4.2.2 UC_2 Information update by Location scout

In a second step, production management will assign a location scout to travel to Corfu and to further investigate the location. Alternatively, this location scout could already live on Corfu or operate in the vicinity. The location scout is provided with the results of the initial query about Corfu and should be able to access the xR4DRAMA system via a mobile application (using a tablet or smartphone). The location scout will now verify and potentially adjust the provided information. The location scout will also add new information which could be text, images, videos (also from UAVs) and data from other available sensors (e.g., temperature, precipitation, noise). The location scout will also explore several suitable shooting locations on Corfu and provide respective information and content. This information and content may include

- additional images and videos of individual sites;
- additional textual information on the sites;
- updated/corrected/improved textual information on various aspects of the specific location;
- information and data deriving from additional means and tools (such as sound samples, 360° images, meteorological data).

All this additional information should be gathered and organised by the xR4DRAMA system. Figure 3 visualises this second phase in the media production planning use case:

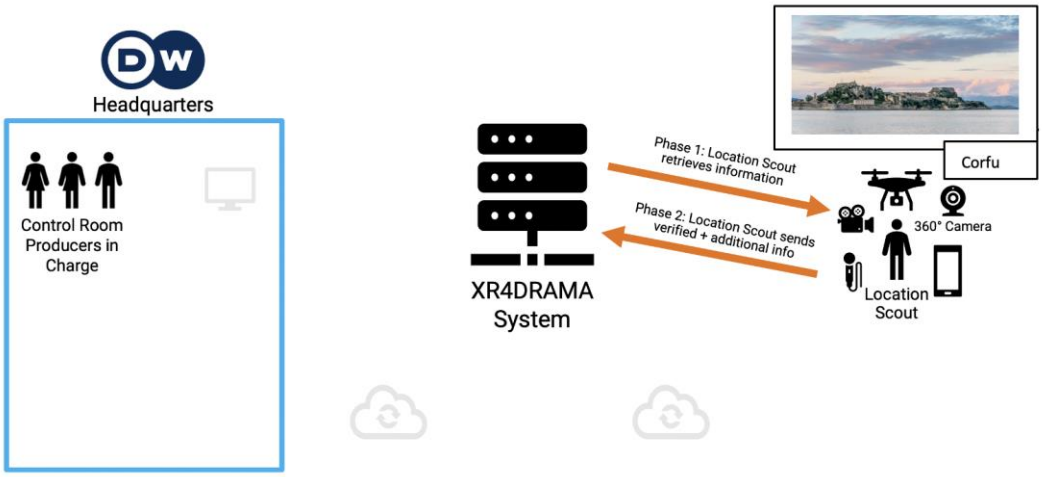

Figure 3: Step 2 of planning the production on Corfu (UC_2)

4.2.3 UC_3 Detailed production planning on the basis of Situation awareness

The final phase in planning the production on Corfu will cover the process where the production management team in the control room receives via the xR4DRAMA platform an aggregation of all relevant information about the various locations on Corfu and creates a detailed production plan. The basis for a good and realistic production plan is that the management team has a very good understanding about the location in question. The more information from available sources they have access to, the better they are able to plan the production. However, as already mentioned in D6.1, information is not all. The production management needs to make creative decisions without being on site. Of course, a lot will be done by the camera crew on the spot, but, nevertheless, organisational and creative supervision remains with the management team. That ultimately means that the management team will strive for as much awareness of the location and the specific production activities, they strive for a maximum of *situation awareness*.

This situation awareness should enable the production management team in the control room to make creative decisions. These could include aspects such as

- which camera angles and shots to aim for;
- which time of the day to use at is offers the best light for the intended effect;
- which camera movements to prioritise,
- whether aerial shots from UAVs should be pursued, require a clear feel for and understanding of the possible outcome.

The more a remote production manager is aware of these very particular circumstances on location, the more he/she is prepared to make sound and sustainable creative decisions.
For this specific moment in the media production planning process, we have identified two further levels of situation awareness (see Section 2.2). As pointed out in D6.1, the xR4DRAMA system will pursue a *Level 2* situation awareness by creating an enhanced

visualisation and representation of available data (video, image, text, sound etc.) that goes beyond a merely appealing presentation of content as described in UC_1. On this second level, the representation of the various locations on Corfu should be immersive enough so that users get a *spatial sense* for the respective location. Whether this spatial sense is achieved by virtual reality, augmented reality or other ways of 3D modelling (or even none of the former) is not crucial. Important is the increased level of situation awareness.

Whilst *Level 2* situation awareness describes the phenomenon of passively experiencing a remote location, user expects the next level to be even more advanced and allow for active interaction with the virtual environment that the xR4DRAMA system will create. This means that *Level 3* should not only present and visualise the various locations on Corfu in a more immersive manner, but should also provide tools through which production managers can test creative concepts. In this context, users imagine the possibility

- "to see" the visual effect of certain shots through the "camera's eye";
- to try out longer and complex camera movements and tracking shots;
- to interact with other team members *within* the virtual environment;
- to test different lighting concepts.

Such functionalities will be immensely helpful for media production planning. It will be cost-effective as it will help to train the camera crew in advance and to avoid try-outs on the ground that will consume time and resources. And it will boost the creative outcome as it will allow for optimising the production from the very beginning. The visual effects in filming very often depend on minor changes in the use of cameras, filters and other tools. Every time of the day creates a different atmosphere. And sometimes, challenging and expensive production techniques (such as aerial shots) make all the difference. The more these approaches can be reliably tested in a controlled virtual environment in advance, the more likely it becomes that the ideal sequence of shots will be achieved within a reasonable production timeframe and at reasonable costs.

With reference to the planned documentary about Corfu this may include

- the option to further explore the old fortress in a virtual or an augmented environment;
- the option to explore a high-resolution 360° image of a very specific spot on an individual site;
- the option to "try out" various shooting missions or camera angles in an immersive environment that delivers a realistic idea of what the real images might look like;
- the option to utilise various (production) tools (e.g., lighting, filters, cranes) in an immersive environment and to study the effects they might have in the real shooting situation.

Ultimately, it is not about how sophisticated the functionalities are that will be provided by the xR4DRAMA system. Crucial is the level of situation awareness that they create. Therefore, the following Figure 4 shows a number of potential HCI devices that can be used

by the production management in the control rooms. The icons in this graphic only represent possibilities; the list is neither obligatory nor final.

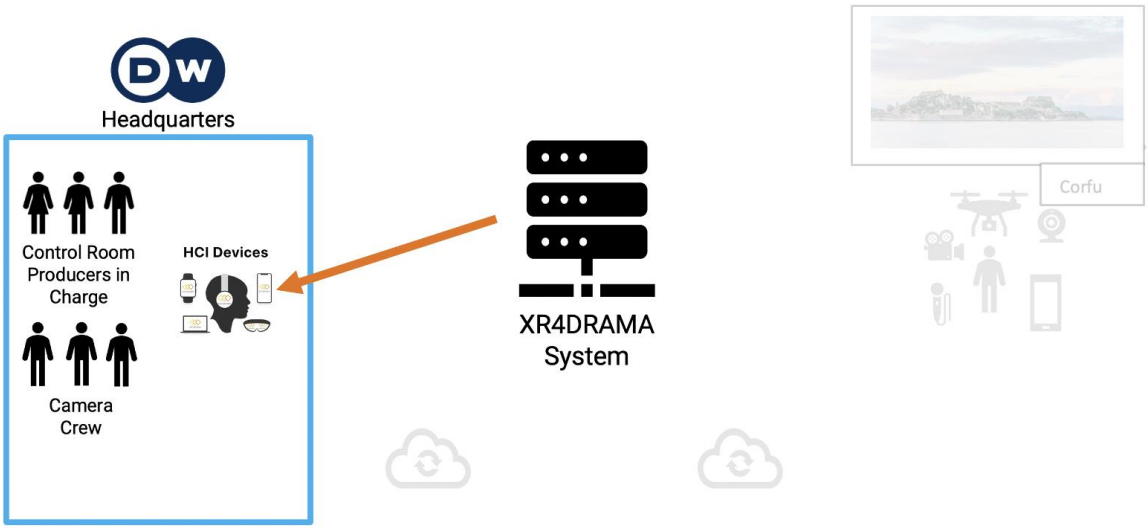

Figure 4: Step 3 of planning the production on Corfu (UC_3)

4.3 Criteria for choosing the specific location

Corfu was chosen as a location for the media production planning use case for several reasons:

- it is easily accessible for all consortium partners;
- weather conditions potentially allow for media production throughout the year;
- it will be more straight-forward for the Athens-based consortium partner U2M to obtain UAV flight permissions in a legal and administration environment that they are familiar with.

But the main reason is that Corfu appears as big and at the same time as small enough to serve as proof-of-concept location for this use case. It offers several locations of interest that provide different filming opportunities and challenges. Distances and transportation on the island are very well manageable. For some areas, the xR4DRAMA platform will be able to benefit from a lot of information that is already available (in various databases, on OSM or in social media outlets) whilst other areas will test xR4DRAMA's capacities of creating situation awareness with hardly any pre-existing information and content.

However, as mentioned before, we might be forced to reconsider the location of Corfu as well as our specific production plan if the pandemic situation worsens again or if certain incidents in the project's development require alternative scenarios.

5 REFINED USER REQUIREMENTS

5.1 Approach

The development of the *refined user requirements* followed the same principles that had guided our work on the initial user requirements. All work was led by the needs of the users with respect to the two use case scenarios. However, we have now introduced a clearer distinction between purely *system-related requirements* that mostly refer to the basic xR4DRAMA functionalities and *information-related requirements* that describe what kind of information and/or content the system is expected to provide. The system-related requirements apply to both use cases equally and are presented in Section 5.2. The requirements identification number (Req Id) starts with the prefix "SYS-". The information-related requirements are further distinguished between *general information* requirements that apply to both use cases and carry the prefix "G-" (Section 5.3.1) and *use case specific information* requirements that start with the prefixes "PUC1-" and "PUC-2" (Section 5.3.2).

The methodology for developing the final user requirements followed the same principles as our work on initial requirements. They mainly stemmed from the users' specific expertise in their respective domain and comprehensive market research about existing (immersive) solutions for improved situation awareness. Additionally, the process was very much guided by intensive discussions with and feedback by technical partners in order to develop a common understanding of the use cases and the background of the individual user requirements.

5.2 System-related requirements

Req Id	Name	Description	Priority (1=high 4=low)
SYS-1	System dashboard and admin interface	An application interface that allows for high-level operators to access the xR4DRAMA system from the control room	1
SYS-2	End-user interface	An HCI that allows end-users to easily communicate with the system	1
SYS-3	Location ingest	Possibility to define a specific location	1
SYS-4	Location-query	A functionality of the system that allows end-users to initiate a query regarding a specific location in web- and cloud services	1
SYS-5	Aggregation of query status and results	The capacity of the system to observe the query and aggregate the identified content (e.g. videos, images, text) in an organised manner (categories, clusters, order)	1
SYS-6	Immersive visual representation	A functionality that visualises the location and additional information to enhance situation	1

Req Id	Name	Description	Priority (1=high 4=low)
		awareness (e.g., VR, AR)	
SYS-7	Initial (Level 1) situation awareness for control room staff	System can present available information in a spatial view • Immersive • Non-immersive • PoV • Bird's Eye	1
SYS-8	Multilingual text generation	The system will provide relevant information in the user's language of choice (English, Italian or German).	1
SYS-9	Edit query results	Control room staff must be able to filter, cluster, annotate and amend the query results	1
SYS-10	Add own data	Control room staff can add images, videos, models or scans to improve data, or change certain data points that might not have been available, e.g., availability of public parking	1
SYS-11	Control room staff is able to send data or tasks (assignments) to other users (e.g. Location Scout, First responders)	The capacity of the system to export any result or visualisation so that it can be used by any other designated user	1
SYS-12	Mobile application	An application that allows for operating the system in and from the field	1
SYS-13	Citizen application	An application that allows citizens to send video, images and audio messages, reporting flooding emergencies (PUC1 only)	1
SYS-14	Remote access to Level 1 situation awareness	The capacity of the system to grant remote users (e.g. location scout) access to a Level 1 situation awareness representation (partly or in total) via the mobile application. Citizens (PUC 1 only) should receive useful information such as alerts, risk zone warnings about areas at risk, position of safe areas, sand-bag distribution, shelters.	2

Req Id	Name	Description	Priority (1=high 4=low)
SYS-15	Information ingest	A functionality that allows the location scout to update information about a specific location and to add videos, images, text as well as data from other sensors	1
SYS-16	System updates	The system processes new input (e.g. from location scout/first responders) and updates previous results and representations	1
SYS-17	Enhanced (Level 2) situation awareness	The updated data is used to create an enhanced version of the scene graph containing all available relevant content and information	1
SYS-18	Advanced (Level 3) situation awareness	The system provides (advanced) functionalities that further increase situation awareness and that can be utilised by control room staff at will: • Possibility to define camera positions • Possibility to simulate camera movements • Add simulations of time (daylight, night) or specific weather situations	
SYS-19	Export situation awareness representation	The capacity of the system to on-demand export visualisation (and other immersive representations).	3

Table 2: System-related requirements

5.3 Information-related requirements

The information-related requirements that had been described on a more general level in D6.1 (Sections 4.3 and 5.3), are now presented in a refined and restructured manner. We have added a column that contains potential sources for the respective information, data or content. However, we need to stress that the named resources are indeed only examples - other or additional sources might be equally suitable. Also, as indicated, different sources might be used for different levels of situation awareness.

5.3.1 General information (both use cases)

The following list refers to information and data that is relevant for both use cases.

Info-ID	Category	Name	Description	Possible source of information or data	Priority (1=high 4=low)

Info-ID	Category	Name	Description	Possible source of information or data	Priority (1=high 4=low)
G-01	Accessibility	Transportation	quality and type of road (highway, street, path), distance to railway station and airport, public transport	LEVEL 1: information via GIS data; LEVEL 2/3: research by location scout	3
G-02	Geography, Surroundings	Buildings, Monuments	the shape, look and size of buildings, the purpose of buildings	LEVEL 1: e.g. Creative Commons, Instagram, Flickr, News Agencies (Gettys Images, DPA picture-alliance), YouTube LEVEL 1/2/3: Visual analysis LEVEL 2/3: research by location scout	1
G-03	Geography, Surroundings	Landmarks	indication of high voltage lines, windmills and other landmarks	LEVEL 1: information via GIS data; LEVEL 2/3: research by location scout	1
G-04	Geography, Surroundings	Roads, Railroads	indication of roads, highways, railroads	LEVEL 1: information via GIS data; LEVEL 2/3: research by location scout	1
G-05	Environmental factors	Weather information	basic weather information through the year or a specific period of time	LEVEL 1: e.g. websites like https://worldweather.wmo.int/en/home.html	1

Table 3: Information-related requirements (General information)

5.3.2 Specific information (Disaster management)

The following list refers to information and data that is of particular relevance for the Disaster management use case.

Info-ID	Category	Name	Description	Possible source of information or data	Priority (1=high 4=low)
PUC1-01	Geography, Surroundings	Rivers, Embankments	indication of rivers, water courses, riverbanks	LEVEL 1: information via GIS data;	1
PUC1-02	Geography, Surroundings	Manholes, electrical and gas pipes	indication of manholes, electrical and gas pipes	LEVEL 1: information via GIS data;	1
PUC1-03	General information	Areas of attention, safe waiting places, shelters	Information on the presence of areas of attention, safe waiting/parking places, shelters, sand-bag distribution areas	LEVEL 1: information via GIS data / website of local authorities; LEVEL 2/3: research by first responders	1
PUC1-04	Flood risk management	Flood maps	Raster data of flow velocity and water depth in flood scenarios	LEVEL 1: information via Raster data; LEVEL 2/3: research by first responders (updated flooding perimeter)	1
PUC1-05	Flood risk management	Risk maps	Information on flood risk level in the territory	LEVEL 1: information via GIS data;	1
PUC1-06	Flood risk management	Flood reports	Information about flood reports localised by audio analysis and categorised according to the problem issue	LEVEL 1/2/3: products from audio and text analysis sent from mobile app for citizens; LEVEL 2/3: research by first responders	1

Info-ID	Category	Name	Description	Possible source of information or data	Priority (1=high 4=low)
PUC1-07	Flood risk management	Flooded elements	Information on flooded elements (e.g. cars and people inside the river)	LEVEL 1: detected/counted from video, images and audio messages sent from mobile app for citizens, social media; LEVEL 2/3: research by first responders	1
PUC1-08	Flood risk management	River embankment's overtopping and/or breaking	Information related river embankments overtopping or breaking	LEVEL 1/2/3: products from audio/video analysis and modelling results; LEVEL 2/3: research by first responders	1
PUC1-09	Flood risk management	Elements at risk	Information on the presence of elements at risk and the degree of emergency	LEVEL 1/2/3: detected/counted from video, images and audio messages sent from mobile app for citizens, social media; LEVEL 2/3: research by first responders	1
PUC1-10	Environmental factors	Sensor measures	Information on environmental variables: water level, rain, temperature, humidity	LEVEL 1/2/3: information from AAWA database or environmental agencies' websites	2

Info-ID	Category	Name	Description	Possible source of information or data	Priority (1=high 4=low)
PUC1-11	Environmental factors	Radar meteo	Information available on radar meteo	LEVEL 1/2/3: information from Civil Protection Department website (http://www.protezionecivile.gov.it/radar-dpc)	3
PUC1-12	Human factors	Physiological parameters	Physiological parameters of first responders in the field	LEVEL 2/3: data by location scout	2
PUC1-13	Human factors	Stress level	detect by stress analysis the stress level in first responders affected by flooding/involved in rescue operations	LEVEL 2/3: sensors for stress analysis	1
PUC1-14	Accessibility	Navigation routes	Possibility to define an appropriate escape route or a suitable way to reach an intervention area	LEVEL 2/3: simulation in system	1
PUC1-15	Geography, Surroundings	Land use change, past flood events' extent	Information derived by satellite images analysis	LEVEL 1/2/3: Information from COPERNICUS satellites	3
PUC1-16	Flood risk management	Population potentially in danger	Information on the potential presence of people in areas at risk	LEVEL 1/2/3: information from AAWA database	1
PUC1-17	Flood risk management	Cultural heritage/natural sites potentially in danger	Information on the potential presence of cultural heritage/natural sites	LEVEL 1/2/3: information from AAWA database	1

Info-ID	Category	Name	Description	Possible source of information or data	Priority (1=high 4=low)
PUC1-18	Flood risk management	Civil Protection Plan procedures	Information on the localisation, type of action, activation threshold of the Vicenza Risk Management Plan procedures	LEVEL 1/2/3: information via website of local authorities/ AAWA database	1

Table 4: Information-related requirements (Disaster management)

5.3.3 Specific information (Media production planning)

The following list refers to information and data that is of particular relevance for the Media production planning use case.

Info-ID	Category	Name	Description	Possible source of information or data	Priority (1=high 4=low)
PUC2-01	Environmental factors	Noise pollution	identification of possible sources like busy roads or highways, crowds of people, factories, airports, railway stations, railway tracks	LEVEL 1: distance to streets/airports/railway stations and similar (e.g. on Google Maps); LEVEL 2/3: noise pollution measured by location scout via a Smartex-device	1
PUC2-02	Environmental factors	Light Pollution	identification of possible sources like streetlights, ads etc.	LEVEL 1: information via GIS data; LEVEL 2/3: research by location scout	2
PUC2-03	Accessibility	Parking	availability of parking	LEVEL 1: information via GIS data; LEVEL 2/3: research by location scout	4

Info-ID	Category	Name	Description	Possible source of information or data	Priority (1=high 4=low)
PUC2-04	Legal Issues	Necessity of filming permit on the ground	necessity of a permission for filming on the ground with a crew	LEVEL 1: e.g. Websites of local authorities; LEVEL 2/3: research by location scout	4
PUC2-05	Legal Issues	Necessity of filming permit in the air	type of permission for filming with drones, possible restrictions for filming	Level 1: websites (in English, Italian and German) like EurLex (e.g. https://eur-lex.europa.eu/legal-content/DE/TXT/?uri=CELEX%3A32018R1139&qid=1614769487831)	2
PUC2-06	General information	General information on site/buildings	textual information on specific sites/buildings in the area of interest	LEVEL 1: e.g. Wikimedia; LEVEL 2/3: research by location scout	2
PUC2-07	Environmental factors	solar altitude during the day	simulation of the course of the sun during a day	LEVEL 2/3: simulation in system	1
PUC2-08	Facilities	Power	availability and accessibility of power outlets	LEVEL 2/3: research by location scout	1
PUC2-09	Facilities	Bathrooms	availability and accessibility of bathrooms	LEVEL 2/3: research by location scout	1
PUC2-10	Facilities	Restaurants, Cafés etc.	list of/indication of available places to eat/drink	LEVEL 2/3: research by location scout	1

Info-ID	Category	Name	Description	Possible source of information or data	Priority (1=high 4=low)
PUC2-11	Facilities	Props&Gear	Possibility to put props/decoration/etc. in the environment	Import of existing 3D Models	2
PUC2-12	Simulation	Drone flights	Possibility to simulate various flights of drones in VR	definition of basic drone flight parameters	1
PUC2-13	General information	Travel- and Security Advice	Information on the security situation in the designated country	Level 1: websites (English, Italian and German) of foreign offices (e.g. https://www.auswaertiges-amt.de/de/ReiseUndSicherheit/reise-und-sicherheitshinweise)	1
PUC2-14	Environmental factors	Noise situation on site	the noise situation on site recorded by the location scout via a Smartex device as mp3-file	LEVEL 2/3: sound file recorded by Smartex device	1

Table 5: Information-related requirements (Media production planning)

5.4 Three levels of situation awareness and visual representations

Beyond the general and specific user requirements as described before, it will be crucial for the project's success to develop a visual concept that allows for three different and increasing levels of situation awareness. Although the consortium has already discussed various options (some of them were already shown in D6.1), we had to realise that it will not be possible to decide on a clear set of visualisations right now. In fact, our conclusion is that the visualisations of the three levels of situation awareness need to be developed in small iterations that are guided by "trial and error" and by regular as well as brief user evaluations.

During this process, we need to establish which kind of immersion does indeed increase situation awareness. This will also depend on the specific moment in a disaster management or in a media production planning process. For instance, disaster and production managers prefer a rather simple visualisation as a first step in order to gain a rough overview of the

situation and the location. Even for the second level of situation awareness it appears to be beneficial to stick with a rather simple visualisation that is now enriched with additional information from people in the field and offers some additional features (e.g. 360° views, augmented reality) that might increase situation awareness.

Only for the third level of situation awareness we expect more sophisticated solutions in 3D, AR and/or VR that will especially allow for direct interaction in and with the respective scene. Regarding the disaster management use case, this could be a 3D representation that allows the control room to have a realistic view of the place where the emergency is occurring (e.g. real flooding conditions, position of elements at risk) to plan the intervention and it allows the first responders to be guided in the action in situ in safe conditions following indications on the best path (to avoid dangerous areas) and identify important information about the intervention to be performed (e.g. building to be secured, person to be rescued). It could also include the option to test various equipment and processes (e.g. cameras, lighting, shooting angles) in a VR environment with regard to the media production planning use case.

In general, it is important to stress that the level of immersion should not be guided by what is technically possible but by what creates added value for the respective manager. A high level of immersion does not necessarily imply an equally high level of situation awareness. In fact, a too immersive environment might overwhelm users emotionally and cognitively and thus reduce their awareness and understanding of the specific situation.

In the Appendices we show various versions of what the visual representations might look like regarding the different levels of situation awareness. These examples are still far from the final images but will serve as a foundation for further discussion and development in the project.

5.5 User interface requirements

A further important aspect of a successful prototype is the quality of the user interface (UI). It is important to state already now that the UI should accommodate the needs and also take into account that end-users are usually not acquainted with the use of tools that might be needed to create an immersive environment (e.g. VR goggles, 360° cameras, complex authoring tools). Those who will evaluate the xR4DRAMA prototypes will be professionals who work in disaster management and in media production. They will expect the system not only to work but also to be handled intuitively and easily. The discussions with potential end-users in the first months of the project have unveiled a great deal of scepticism towards the suggested functionalities. This scepticism (that is normal when new tools are introduced) can only be overcome if the front-end development follows the principles of end-user-oriented UI design.

Accordingly, the evaluation of the first and the final prototype will also include *usability testing*. We understand usability testing as an activity that focuses on observing users working with a product, performing tasks that are real and meaningful to them. More

precisely, we intend to measure the level of *effectiveness*, *efficiency*, and *satisfaction* that users experience when they use the xR4DRAMA platform in order to achieve specified goals. ISO 9241-11 (the standard covering the ergonomics of human-computer interaction) provides definitions for these three criteria:

- **Effectiveness:** depends on to which extent is the user able to fulfil the task and to achieve his goals.
- **Efficiency:** depends on how the effort the user needs to invest relates to the accuracy and completeness of the results
- **Satisfaction:** depends on how satisfied is the user by working with the system.

All these criteria will play a role in the user evaluation and the front-end design should be mature enough to accommodate this kind of tests.

6 FURTHER WORK ON PILOT USE CASES AND USER REQUIREMENTS

The submission of D6.2 marks the end of the first phase of activities in WP6. The pilot use cases should be clear and the user requirements considered as final. However, the user partners AAWA and DW will continuously accompany the further development of the xR4DRAMA platform and its individual functionalities.

6.1 Continuous interaction with technical partners

Although this deliverable contains a comprehensive and concise description of the use case scenarios and the user requirements, successful further (development) work within the project requires a continuous interaction between technical and user partners. This does not only refer to the evaluation of the first and the final prototype but also to smaller development steps (e.g. regarding individual modules) in the meantime. Thus, we will be able to guarantee that all development in xR4DRAMA is driven by practical user needs and the principles of usability. As already mentioned before, especially the very important question of how to visualise the different levels of situation awareness requires ongoing discussion and interaction between technical partners and user partners (see Section 5.4). The same refers to the design and the architecture of the user interface (see Section 5.5). But beyond these two crucial aspects, ultimately all development activities will benefit from a close cooperation by all partners throughout the project.

6.2 Evaluation

The two user partners, AAWA and DW, are also responsible for evaluating the xR4DRAMA platform and its functionalities. The DoA foresees two evaluation cycles: One after the first prototype has been accomplished in M13, and a second one with regard to the final prototype which is supposed to be completed in M22. In this context, it is important to clearly distinguish between *technical evaluation* and *user evaluation*. Technical evaluation of the individual components as well as of the integrated system will be carried out exclusively within the respective technical work packages and according to acknowledged technical validation metrics. These tests will follow their own schedules and are not part of WP6. User evaluations, on the other hand, will focus on the aspect of usability of individual components as well as of the xR4DRAMA system as such. In D6.1, we have already described some principles on the basis of which we intend to carry out our evaluation activities. A comprehensive evaluation methodology will be developed in the months before evaluation and will be detailed in the first evaluation report (D6.3).

7 SUMMARY AND CONCLUSION

The (refined) user requirements as presented in this deliverable have not fundamentally changed in comparison with the initial requirements that we have described in D6.1. However, we realised that we needed to introduce a new distinction between *system-related* and *information-related* requirements. The former refer to basic functionalities of the xR4DRAMA system and its components should provide. The latter, on the other hand, describe the categories of information and data that are relevant for the respective use cases. We have also identified a number of sources where this information could originate from.

Another important aspect of this deliverable is the further specification of the two use cases. This mainly refers to the specific locations (the city of Vincenza and the island of Corfu) that will serve as the basis for show-casing and testing at least the first prototype. We will decide during the further course of the project whether we will move to additional locations. The pandemic situation does not allow for making this kind of decision right now.

Finally, we have used the last months to work on some more ideas about what the visual representations of three levels of situation might look like (see Appendices section). The final representation might look different depending on the quality of the data and imagery that can be collected. However, we believe that the specified use cases, the refined user requirements and the more detailed mock-ups that are presented in this deliverable will be a clear and at the same time flexible guidance for development work within the project. After the evaluation of the first prototype, D6.3 will deliver a new update on the user requirements.

A Appendices

A.1. Appendix 1: Various visualisations of a main square of Bremen

In order to develop an idea of what the visual representations on the individual levels of situation awareness (SA) might look like, we have chosen the main square in Bremen in order to test different approaches. In the following, we present two exemplary visualisations for each level.

Figure 5: Aerial view of the square in Bremen (Level 1 SA)

Figure 6: 3D model of the square in Bremen with additional information (Level 1 SA)

Figure 7: Virtual 360° representation of the square including additional information (Level 2 SA)

Figure 8: 360° photo of the square (Level 2 SA)

Figure 9: Virtual 360° representation of the square (morning light impression) (Level 3 SA)

Figure 10: Virtual 360° representation of the square (afternoon light impression) (Level 3 SA)

A.2. Appendix 2: Various visualisations of the old town of Corfu

In the following, we are showing various images/screenshots of the old town of Corfu that might serve as visual representations of the different levels of situation awareness. Again, these are only preliminary examples that are intended to trigger further discussion and development.

Figure 11: Map of the old town of Corfu (Level 1 SA)

Figure 12: Aerial shot of the old town of Corfu (Level 1 SA)

Figure 13: Map of the old town of Corfu with additional information (Level 2 SA)

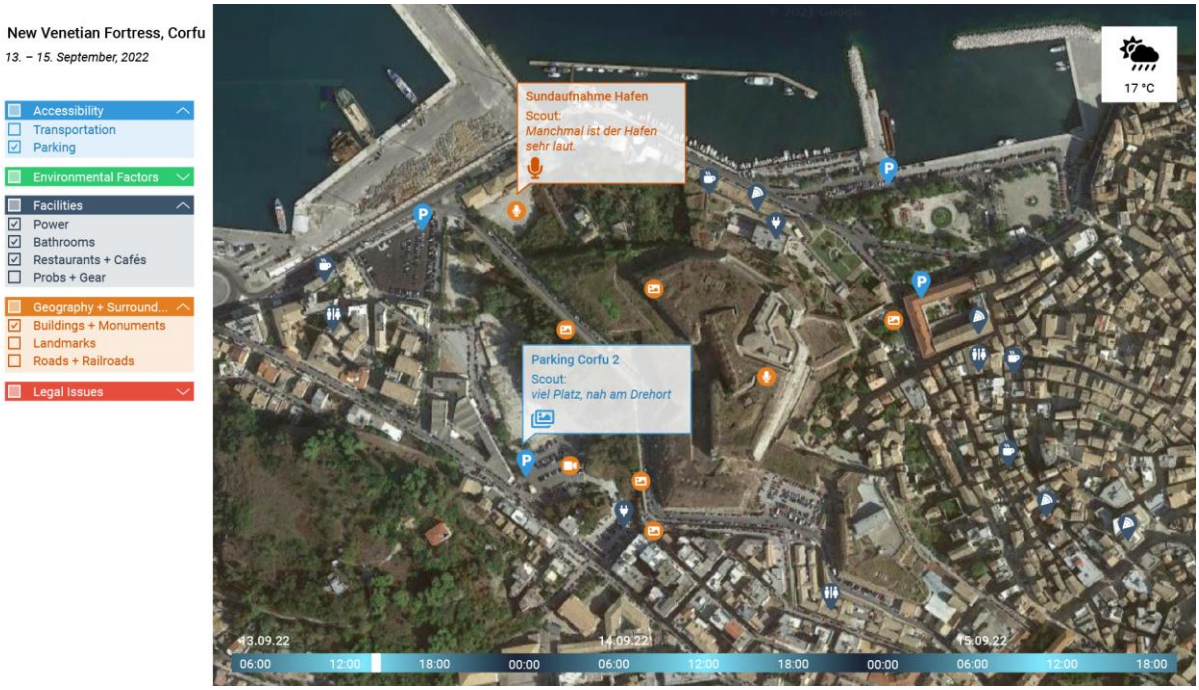

Figure 14: Map of the old town of Corfu with additional information (Level 2 SA)

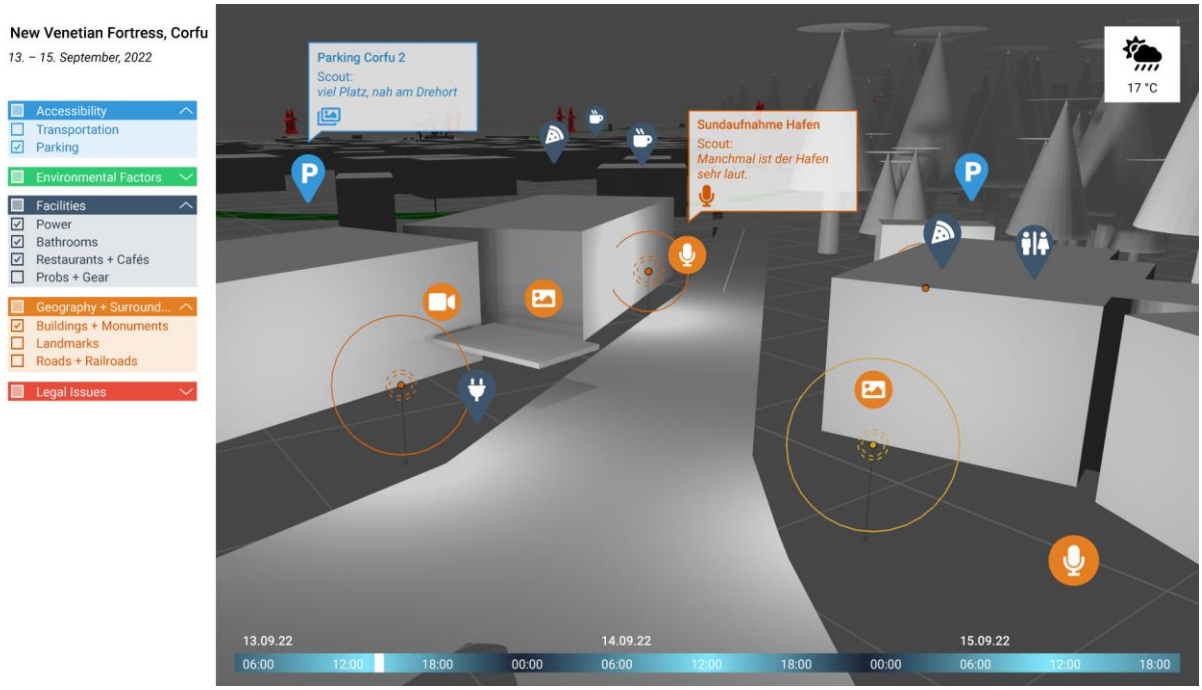

Figure 15: Virtual 360° representation of the square including additional information (Level 2/3 SA)