IOPES

Indoor-Outdoor Positioning for Emergency Staff

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D3.1: Analysis of User Requirements

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IOPES

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Acronyms

CPE	Civil Protection Emergency
CPET	Civil Protection Emergency Team
CTTC	Centre Tecnològic Telecomunicacions de Catalunya
EMS	Emergency Management Systems
FBBR	Frederiksborg Brand og Redning
IOPES	Indoor and Outdoor Positioning of Emergency Staff
KP	University College Copenhagen
RPAS	Remotely Piloted Aircraft System
SLAM	Simultaneous Location and Mapping
UC	User Case
UR	User Requirement
WA	Weighted Average
WP	Work Package

1. Executive summary

The present document is the first of two deliverables of Work Package 3, as part of the IOPES project. The IOPES project intends to improve the response phase of an emergency with an already existing operational tool by enhancing collection, usage and storage of positioning data. This report presents an evaluation of civil protection emergency teams' requirements related to positioning, mapping, communications and emergency management systems.

To establish the importance of the user requirements, a survey and qualitative interviews forms the background of the analysis. Unfortunately, the number of respondents was sparse, most likely due to the Corona virus pandemic. However, with the combination of survey results and the support of the qualitative interviews, the analysis is assumed to be validated.

The results led to the conclusion of several requirements, especially in the category of emergency management systems as distinguished by country. Finally, all the respondents agree that the IOPES system and device needs to be robust to all kinds of weather and related conditions. However, there appears to be disparity amongst the respondents in terms of how multi-functional the system should be.

The user requirements have been assigned a level of priority in order to better facilitate a subsequent selection, development and implementation of the forthcoming IOPES system and device.

2. Introduction

The Indoor and Outdoor Positioning for Emergency Staff (IOPES) project is a European Union-funded project intending to strengthen the preparedness of civil protection and emergency teams (CPETs), with a special focus on flooding and seismic events. The present dissemination is the first of two outputs for Work Package 3 (WP3): (i) analysis of user requirements and (ii) test scenarios. The aim of the current analysis (WP3.1) is to define and analyse user requirements relating to positioning, mapping, communications and emergency management systems (EMS). WP3.1 includes a collection of user requirements and a further evaluation of the priority of these requirements.

The main objectives are to provide continuous time-tagged information on the in- and outdoor geo-localisation of the CPETs and to incorporate fast delivering cartography through the support of Remotely Piloted Aircraft Systems (RPAS). The IOPES project intends to enhance an existing operational tool by improving its ability to collect, use and store positioning data which may facilitate better decision-making during the response phase and support a post-mortem analysis to improve future procedures.

2.1. Methodology

The empirical material consists of (i) a kick-off meeting held on 15.01.2020 with IOPES partners; (ii) an end-user meeting held on 16.01.2020 with IOPES partners and end-users from Spain and Italy); (iii) a survey; and (iv) in-depth interviews. The data that supports the analysis of user requirements derive from the survey and interviews. Data from these sources provide the background of the analysis, findings and conclusions contained in this report.

The survey was initially constructed in order to obtain insight into patterns and distributions, e.g. across countries, frequent incidents and respondents' profession in Civil Protection Emergency (CPE) organisations. The intention was to secure answers from a larger group of respondents concerning a number of identified variables with a focus on user requirements for the system. Some of the variables were identified by the IOPES project and some refer to findings in previous and on-going EU-funded research and development projects which to some degree share IOPES's objectives.

A snowball sample approach was applied to secure variety among respondents completing the survey (Coleman, 1958-59). The IOPES partners involved in WP3 contributed to disseminating an invitation to take part in the first phase of the data collection. The deadline for returning the completed survey was postponed three times, with a total extended time of about one month. Due to the outbreak of the Corona virus pandemic, it was not possible to obtain the ideal number of respondents, however, the distribution of survey responses is well dispersed among different countries and geographical conditions, and thereby represents a variety of often occurring incidents. Table 1 shows the distribution of survey respondents in European countries.

#Respondents per country per category	Spain	Denmark	Germany	Iceland	Italy	Poland	*Total # respondents per category*
Demography	7	7	4	1	1	1	*21*
Indoor positioning	6	5	4	1	1	1	*18*
Outdoor positioning	5	5	3	1	1	0	*16*
Communication	5	4	3	1	1	0	*14*
EMS	4	4	3	1	0	0	*12*
Mapping	4	4	3	1	0	0	*12*
MAX per nationality	*7*	*7*	*4*	*1*	*1*	*1*	*21*
MIN per nationality	*4*	*4*	*3*	*1*	*1*	*0*	*12*

Table 1 Degree of completion for survey and interview respondents.

The respondents who completed the entire questionnaire represent Spain, Denmark, Germany and Iceland. The representative from Italy completed the In- and Outdoor positioning as well as the Communication category. The representative from Poland responded to the Demographic questions and Indoor positioning and answered 'not applicable' to all positioning-related requirements. Italy is not represented in the EMS and Mapping categories.

The occupation of the respondents is as follows: 52% are incident commanders, 48% have registered themselves as chief of staff and 14% as team leaders. In addition, 10% of respondents registered as a technician or researcher. Moreover, several of the respondents are experienced in their current profession, where 33% have more than 20 years of experience and 28% have less than five years' experience.

In order to address the requirements as defined by the IOPES partners the survey contained 50 questions and the estimated required time is 30–45 minutes. Unfortunately, not every respondent completed all the sections of the survey, as shown in Table 1, which displays the degree of completion.

Following the survey, a qualitative interview study was undertaken in order to secure an in-depth analysis of the experiences and reflections of CPE managers, also referred to as end-users. Four of the survey respondents agreed to be contacted for a further qualitative interview, however only three interviews were successful. Additionally, two respondents were invited by the IOPES partners, which resulted in a total number of five interviews (Table 1). It has been difficult to get in contact with officials in the European countries, as a severe workload has been placed on them due to the Corona virus. A higher number of respondents to both the quantitative and qualitative portions of the data gathering would have been obtained under ordinary conditions.

The qualitative interviews provide insights into the possibilities, constrains, pitfalls and needs among end-users of the IOPES system. It is assumed that it is a well-suited method to support the evaluation of a quantitative analysis based on survey results. In addition, the qualitative interviews allow new perspectives to be introduced by the interviewees. Five CPE professionals each representing their countries (i.e. Spain, Denmark, Germany, Iceland and Italy) agreed to engage in an hour-long teleconference interview. The interview respondents represent IOPES partners as well as CPET end-users. Following a semi-structured interview guide, they were asked to expand on some of the most important findings of the survey study. Here, they were asked to speak about their own experiences and how experiences, working conditions, local organisational setup and incident types influence their requirements for a positioning system. In the present report the findings from the qualitative interviews play a significant parallel role to the findings from the survey, where they reveal or support correlated parameters, e.g. country-specific or individual-specific requirements.

Both the survey and interview respondents retain anonymity, though the interviewees are referred to by their nationality. Permission to do so was provided in writing.

2.1.1. Pre-defined User Requirements

Prior to the user requirements analysis, the IOPES consortium collected an approximate list of functionalities that the IOPES system would offer the CPETs. The user requirements have been identified with support from various sources. This report intends to evaluate specified end-user requirements based on a formalised study including an end-user meeting, survey and in-depth interviews.

The initial IOPES proposal (+12 URs) and end-user meeting (+7 URs) held in January has contributed to the identification of most of the user requirements. KP was not present at the end-user meeting (2020), however the minutes of the meeting was used as a source for certain requirements. In addition, the H2020 HEIMDALL project (2019) (+10 URs) has been an inspiration for several requirements, focusing on requirements concerning a multi-hazard cooperative system for managing data exchange, response planning and scenario building. Furthermore, the pre-defined requirements originate from the projects listed in the order in which they have contributed the most (Table 2):

- Initial IOPES proposal +12 URs
- H2020 HEIMDALL project (2019) +10 URs
- IOPES end-user meeting +7 URs
- H2020 BeAWARE (2017) +6 URs
- H2020 AIOSAT (2020) +5 URs
- H2020 Driver+ (2014) +4 URs
- FP7 RECONASS (2016) +3 URs
- H2020 IN-PREP (2020) +2 URs
- H2020 SAYSO (2018) +1 UR
- H2020 I-REACT (2020) +1 UR
- H2020 EOPEN (2019) +1 UR

Type of requirement	UR#_code	Source of requirements
Mapping	UR1_map	End-user meeting, RECONASS
Mapping	UR2_map	End-user meeting
Mapping	UR3_map	Heimdall, BeAWARE
Mapping	UR4_map	RECONASS
Mapping	UR5_map	Heimdall, BeAWARE, RECONASS
Mapping	UR6_map	End-user meeting
Mapping	UR7_map	Heimdall, BeAWARE, I-REACT
Mapping	UR18_map	Heimdall, Driver+, SAYSO
Mapping	UR19_map	End-user meeting, Heimdall, BeAWARE, EOPEN, Proposal
Mapping	UR30_map	BeAWARE, Proposal
Positioning	UR8_pos	AIOSAT
Positioning	UR9_pos	AIOSAT
Positioning	UR10_pos	Proposal
Positioning	UR11_pos	AIOSAT
Positioning	UR12_pos	AIOSAT, Proposal
Positioning	UR13_pos	End-user meeting
Positioning	UR14_pos	End-user meeting
EMS	UR15_ems	Driver+
EMS	UR16_ems	Heimdall, BeAWARE
EMS	UR20_ems	Proposal
EMS	UR21_ems	Proposal
EMS	UR22_ems	IN-PREP
EMS	UR23_ems	Driver+
Communication	UR24_com	Driver+
Communication	UR26_com	Heimdall
Communication	UR27_com	Heimdall, Proposal
Communication	UR29_com	Proposal
Communication	UR31_com	Proposal
Communication	UR32_com	Proposal
Communication	UR34_com	Heimdall
Communication	UR35_com	IN-PREP

Table 2 Pre-defined user requirements.

Some of the URs were excluded from the original list of requirements, which is why the numbering of URs is unordered.

Reviewed documents can be found in the section titled Reference Documents, presented at the end of the document.

The URs for each type of requirement are listed in the subsections. For each UR ID there is assigned a code in the format: UR_«ID»_«Code». The «ID» refers to the UR#, followed by a «Code» indicating the type of functionality the requirement is intended for. The codes can have the following values:

- UR#_map: Mapping
- UR#_pos: Positioning (including in- and outdoor)
- UR#_ems: Emergency Management System
- UR#_com: Communication

2.1.2. Method of Data Treatment

The aim of the present analysis is to evaluate the importance of the pre-defined user requirements. The user requirements are assigned a priority (low, medium or high), which will support the continuous work of the IOPES project. This is done through an evaluation of the survey results supported by the qualitative interviews.

The survey mainly addresses two perspectives: (i) the level of importance and (ii) the level of precision (Figure 1). From these two types of questions, the respondents were obliged to reply within a range of four levels for each perspective. The level of precision ranges [1–4], where 1 refers to a requirement for a less accurate positioning:

1. *Less precise* refers to a precision within 10m (<10m)
2. *Moderate precise* refers to a precision within 5m (<5m)
3. *Precise* refers to a precision within 2m (<2m)
4. *Very precise* refers to a precision within 1m (<1m)

The level of importance ranges [1–4], where 1 refers to the requirement having no importance:

1. *Not important*
2. *Less important*
3. *Important*
4. *Very important*

The level of precision and level of importance share the same scale of values, which allows for the adoption of a priority scale, where the following intervals equal the level of priority (Figure 1):

Value 0–1.5 equals *no priory*
Value 1.5–2.5 equals *low priority*
Value 2.5–4 equals *high priority*

The level of priority ranges from: (i) low; (ii) medium; and (iii) high, which are described as:

- *Low priority* is given to the requirements that merely bring in added value if present, however are not necessary of the functionality of the IOPES project. It ranges from *not important* to *less important*.
- *Medium priority* is given to the requirements that add the necessary functionalities ensuring a fundamental value of the IOPES system to the end-users. A medium priority ranges from *less important* to *important*.
- *High priority* is assigned to the requirements that are absolutely required by the end-users. It ranges from *important* to *very important*.

Weighted avg.	0	1	2	3	4
Level of importance	N/A	Not important	Less important	Important	Very important
Level of precision	N/A	Less precise <10m	Moderate<5m	Precise <2m	Very precise <1m
Priority scale	No priority	Low priority	Medium priority	High priority	

Figure 1 Priority scale.

The user requirements are prioritised according to the weighted average (WA), which is a numeric value adopted from the survey results. The WA is computed by assigning the value of the answers corresponding to the level of priority. For example, out of 20 respondents, 15 answered *very important* (equivalent to a value of 4), and 5 answered *less important* (equal to a value of 2). The WA is thus calculated as:

$$\frac{15 * 4 + 5 * 2}{20} = 3.5$$

In this example, the WA for the 20 respondents is 3.5, which indicates a level of priority that is considered high. In cases where multiple survey questions (SQ) relate to a specific user requirement, the mean value of the WA is simply computed, e.g. SQ1 has a WA of 3.5, however SQ12 (WA of 2.8) and SQ18 (WA of 3.6) also correspond to the UR#. The mean value for WA_{SQ1}, WA_{SQ12} and WA_{SQ18} is computed as:

$$\frac{3.5 + 2.8 + 3.6}{3} = 3.3$$

The WA derived from the survey questions is further supported by the qualitative interviews in order to determine the assigned level of priority for each UR. The information derived from the interviews has not been assigned any numeric value, however they may increase the priority of the URs.

3. User Needs Analysis

The current chapter presents an evaluation of the user requirements by introducing the overall type of requirement as well as additional findings. The user needs analysis follows the four pillars of the IOPES project, which includes: (i) Mapping; (ii) Positioning; (iii) Emergency Management Systems; and (iv) Communications. The evaluation is based on results from both the survey and qualitative interviews. For each section, the UR# priorities are summarised and further findings from selected interviews are descriptively presented.

The main scenarios that are of interest to the IOPES project are *flooding* and *seismic events*, although alternative types of emergencies may be a source of reflection for the interviewees and respondents.

3.1. Mapping

One of the objectives in the IOPES project is *mapping*, which is a necessary part of the current research scope. The idea is that the CPETs may rely on existing cartography or fast mapping to gain better situational awareness and therefore support the decision-maker.

Based on conversations with end-users of the IOPES consortium, the primary concern related to time-consuming issues that prevent a quick start of necessary activities in emergency situations. One of the common causes that was identified early in the project was a lack of updated cartography. Non-existing or outdated cartography may exclude essential obstacles interfering with the emergency. The IOPES project intends to solve the issue of having outdated cartography by providing the mechanisms to incorporate fast and seamlessly updated maps produced by means of RPAS.

The following list presents the survey questions concerning mapping requirements:

- How important is it to you that you are able (through the device) to receive information from victims and affected people?
- How important is it to you that the device provides detailed photos of the damaged structure?
- How important is it to you that the device can provide visual information on the following? (i) Visual information on flooding; (ii) Damaged areas; and (iii) Traffic jams
- Rank the environment in which the device should be capable of operating in the order of importance? (i) Cold weather; (ii) Rainy and wet; (iii) Darkness and limited light; and (iv) Heat and drought
- How important is the following, that the user should be able to feed the system during an incident? (i) Photo; (ii) Video; (iii) Text; and (iv) GPS coordinates
- How important is it to you that firefighters can provide specific types of information from within the incident to you as a team leader/incident commander?

The requirements regarding mapping illustrated the importance of visual information and updated cartography (including video and photo), communication with RPAS and the operability in all weather conditions. The following section presents the most interesting findings that correspond to the UR#_map.

3.1.1. Results

Three out of the four representative countries (the representative countries being Spain, Denmark, Germany and Iceland) value the importance of visual information in the form of mapping, whereas the representative from Iceland showed very little interest in these types of requirements (Figure 2).

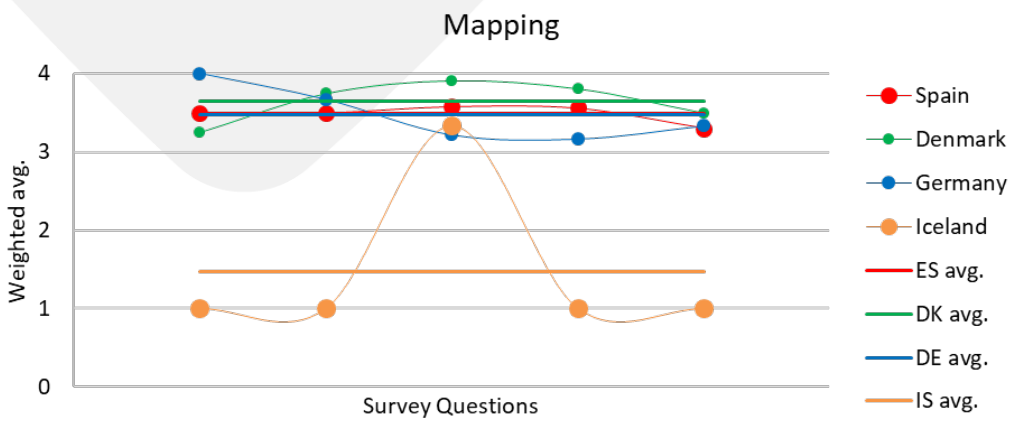


Figure 2 WA results for mapping survey questions.

The WA is an average value [1–4] of respondents' replies to the importance and/or precision of a given survey question. A high WA indicates that respondents want a very accurate precision and/or that they suppose the requirement is very important. Conversely, a low WA indicates that respondents want less accurate precision and/or they suppose the requirement is not important. The illustrated average assigned to each country is the mean value of the WAs (Figure 2).

Visual information
The Icelandic interviewee requires a simple tracker device with less visual information available, providing only GPS coordinates for CPETs and relies on other tailor-made technologies to serve their purpose instead. The preferable size is similar to a large pager. The Danish, German and Spanish interviewees require a device with visual information such as cartography, photos and videos, where cartography and GPS coordinates are integrated into the other information. The preferable size is similar to an iPad.

Information provided from victims, affected people and goods are evaluated as *very important* for 75% of the survey respondents. Most of the respondents appear to require detailed images of damaged structures as well as requiring the possibility to feed the system with geo-localised photos, corresponding to UR3_map, UR4_map and UR7_map.

Interoperability
All interviewees agree that interoperability with existing technologies such as RPAS, body cameras, helmet cameras and the TETRA communication system is valuable for their decision

making. This corresponds to UR2_map and UR5_map, which address the connectivity to the RPAS providing images and videos. As mentioned by the Spanish interviewee, the RPAS is used during a search and rescue operation or to obtain an overview when managing a flood or similar situation. The RPAS may very well be connected to the IOPES system, enabling the CPE decision-maker to have geographical awareness.
According to the Danish and Spanish interviewees, the geographic information system (GIS) is currently used to monitor CPE vehicles during an incident. The information is sent to the offsite control station, also referred to as the emergency management system (EMS). If the onsite commander requires the GIS data, the EMS can provide it to him/her on demand. However, this application is mainly implemented when the incident area is geographically large, and/or a vehicle with specialised equipment is onsite.

Updated cartography
Based on the survey results, the majority of the respondents agree on the high level of importance of having updated cartography (relates to UR18_map and UR19_map) and with an acceptable time delay between 0 and 5 minutes for communicating video, photo, audio and text (corresponds to UR30_map).

Weather conditions
When asking the respondents to rank the type of environment in which the device should be capable of operating in (1 is most important, 4 the least), Table 3, the answers appear to be diverse. Spain, Denmark and Germany agree that rainy conditions are the most relevant, whereas the representative from Iceland ranked rain as number three. Denmark ranked cold climate as having the same high priority as rain, whereas Iceland ranked cold weather as the least important weather conditions. Most respondents agree that heat and drought are less important. The individual prioritisation of challenging environments demonstrates a possible tendency seen in the analysis of a diversity of requirements that may be country specific.

Rank relevant environments	Spain	Denmark	Germany	Iceland
Cold weather	2	1	3	4
Rainy or wet	1	1	1	3
Darkness or limited light	1	2	2	1
Heat or drought	3	3	4	2

Table 3 Prioritisation of relevant weather conditions divided by nationalities.

The survey reveals a consensus on the high importance of a waterproof device. According to all interviewees, the robustness of the device when being exposed to rain, vibrations and shocks including direct sunlight is very important, corresponding to UR1_map.

The importance of day and night use corresponds to UR6_map, where the respondents were asked about the level of importance of having the device operable at night and in daylight. Spain, Denmark and Germany value night visibility in outdoor conditions slightly higher than indoor conditions. The representative from Iceland values night visibility as a less important feature for both in- and outdoor conditions. The overall average level of importance is ranked “less important” for indoor and “important” for outdoor conditions.

Diversity of user interface

An additional comment during the qualitative interviews regards a differentiation of user interface corresponding to the level of management of the end-user. As the German interviewee mentioned, the system must have different abstraction levels corresponding to the usability purposes. For instance, the onsite commander requires a less detailed map, whereas the offsite commander and the EMS require more detailed information. The user accessibility may also differ according to the individual purposes; the onsite commander may need to supply the system with simple information, e.g. fixed GPS coordinates, whereas the offsite commander and EMS may need to feed the IOPES system with specific data or even modify data for the onsite commander to view.

3.1.2. User Requirement Priorities

The mapping requirements are specified in Table 4, including an assigned level of priority [low, medium, high]. The priority level is based on the mean value of the WA for the survey questions related to the user requirement, as well as the results from the qualitative interview.

The overall level of importance for requirements concerning fast mapping and cartography is considered rather high among the respondents. However, there may appear to be a diversity in the responses differentiated by nationality, where Iceland differs from Spain, Denmark and Germany by viewing mapping requirements as less important in general. Nevertheless, the average priority between all respondents is weighted within the range of important to very important. The requirements related to RPAS communication are evaluated as having a medium priority. The remaining UR#_maps are evaluated as having high priorities amongst the end-users.

When the respondents were asked to rank the most relevant weather conditions, the answers differ according to nationalities. Most of the respondents agree on a high level of importance of having the system operable in all weather conditions as well as being operable with and without sunlight. In summary, the respondents view visual information such as videos, photos, cartography and the like as being important, hence the assigned high priority. However, when the respondents were asked to assess the importance of having the IOPES device communicate with the RPAS, the response was less important, hence the assigned medium priority.

UR#_code	**Requirement description**	**Priority** low/medium/high
UR1_map	Device shall be operable in daylight and at night in all weather	High
UR2_map	Need to have imagery and live video from the RPAS during the whole emergency (day and night period)	Medium
UR3_map	Provide information from victims, affected people, goods, and/or geo-localisation	High
UR4_map	The system shall provide detailed imagery of the damaged structure	High
UR5_map	The user shall be able to detect flood events, damaged areas, traffic jams and road obstructions using information provided by the RPAS	Medium
UR6_map	Capacity to be operational with few hours of daylight per day	High

UR7_map	The user in the field shall be able to feed the system with geo-localised pictures and/or reports from the affected area	High
UR18_map	Capability to load critical asset/infrastructure maps	High
UR19_map	Need to have high resolution cartography produced very quickly following a disaster	High
UR30_map	Capability to load and visualise updated cartography	High

Table 4 End-user requirements (mapping) with assigned priorities.

Extracts from Interviews

Germany
Usability is a keyword for the German interviewee. According to the German interviewee, the available features including visible information and mapping should be adjusted in accordance with the user.

Iceland
"The simpler usability, the better," though without compromising the highly developed software engineering. According to the Icelandic interviewee, the device should be used for one specific purpose, namely positioning CPET members. The Icelandic interviewee is not confident that an integration of the functionalities of a mobile telephony, the TETRA system and the like will support the IOPES system. Simplicity is a keyword for the Icelandic interviewee.

Italy
Based on current practice, the Italian interviewee sees the possibility of the RPAS being connected to the IOPES device as a great opportunity for better decision-making during a search and rescue in a collapsed buildings or seismic area.

Denmark
Based on experience, the Danish interviewee suggests interacting with the cartography or map may improve coordination and communication between CPE management. This means that the decision-maker can assign specific points or coordinates in the map, including modification of these for the EMS or other decision-makers.

3.2. Positioning

The main pillar of the IOPES project includes *positioning* of CPETs in- and outdoors, thereby wearing sensors which allow for the transmission of positioning data to the EMS by means of a communication system. The aim is to identify the end-user's requirements regarding such a positioning device being capable of providing timely and precise information about the location of the members of the CPETs. The objective is to provide a device that can support and enhance the response capacity of the emergency decision-makers.

Outdoor positioning systems are commonly based on GNSS receivers, which are rather common, however indoor positioning systems are not yet recognised in emergencies. Consequently, EMS do not keep track of CPETs when entering buildings and the like. Recently developed, though not yet established on the market, a Simultaneous Location and Mapping (SLAM) can provide indoor positioning (Cadena, et al., 2016). The IOPES project aims to integrate SLAM and a GNSS receiver that can track CPETs both in- and outdoors during emergencies.

The following list represents the survey questions related to positioning, for which the questions were repeated twice, for both indoor and outdoor conditions:

- How relevant is it to you to know the exact location of the emergency teams during an operation?
- How precise of a geo-localisation (horizontal) of the emergency team do you need in the following circumstances? (i) Seismic events; (ii) Flooding
- How precise of a geo-localisation (vertical) of the emergency team do you need in the following circumstances? (i) Seismic events; (ii) Flooding
- How important is (updated information on) positioning for you in the following statements? (i) 3 updates per hour; (ii) Real-time update
- How important is the weight of a device allowing you to geo-locate the emergency team during an emergency?
- How important is it to you that a device can operate in temperatures of -10 to 100 degrees Celsius?
- How important are the following requirements for the device to you during emergencies? (i) Light weight; (ii) A wearable device; (iii) Night visibility; (iv) Manageable with gloves; (v) Waterproof; (vi) Touch screen; and (vii) Equipped with physical buttons

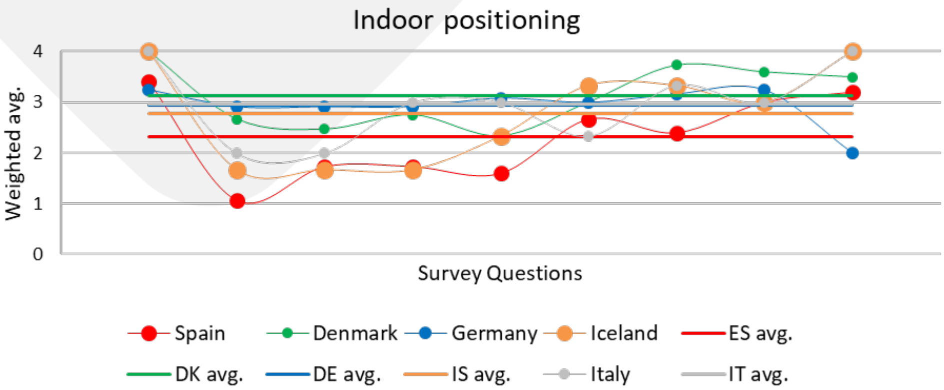
The current subsection presents an overview of the end-users' requirements regarding the level of precision of geo-localisation of CPETs, the required frequency of positioning data, hardware specifications and the level of confidence when relying on positioning technology as supporting decision-making.

3.2.1. Results

According to the survey results, the respondents appear to agree that positioning is important to some degree. When evaluating the survey results derived from in- and outdoor positioning, including the response from the respective interviewees, the UR12_pos is considered important.

The represented countries, i.e. Spain, Denmark, Germany, Italy, Poland and Iceland, show a rather distributed set of WA outputs (Figure 3). Poland is represented by one respondent, who responded *not applicable* for both in- and outdoor positioning, which is why Poland does not appear in Figure 3.

The scatter plot illustrates the WA, including the mean WA, per country for positioning in- and outdoors. Both diagrams show a rather scattered set of outputs in two aspects: (i) the positioning requirements seem to be country-specific and (ii) the level of importance of the pre-defined UR#_pos varies by country.



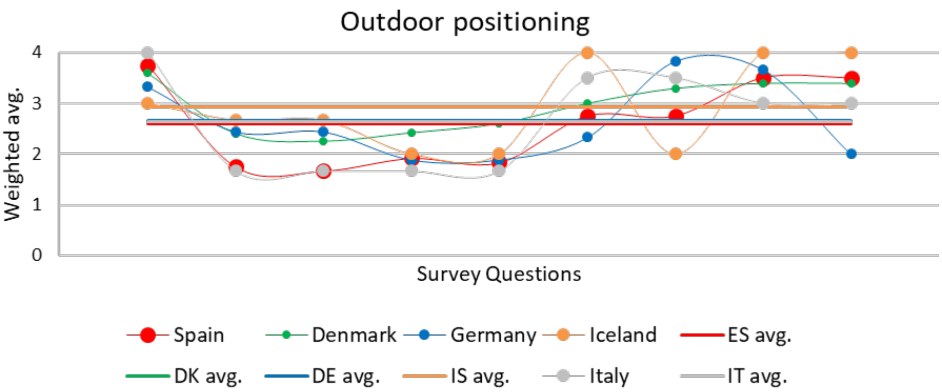


Figure 3 WA for in- and outdoor survey questions.

Horizontal and vertical positioning

When comparing the mean value of each country's WA for in- and outdoor positioning, Spain and Iceland value the importance of outdoor positioning higher than indoor, while Denmark, Italy and Germany appear to value indoor positioning higher than outdoor (Figure 4).

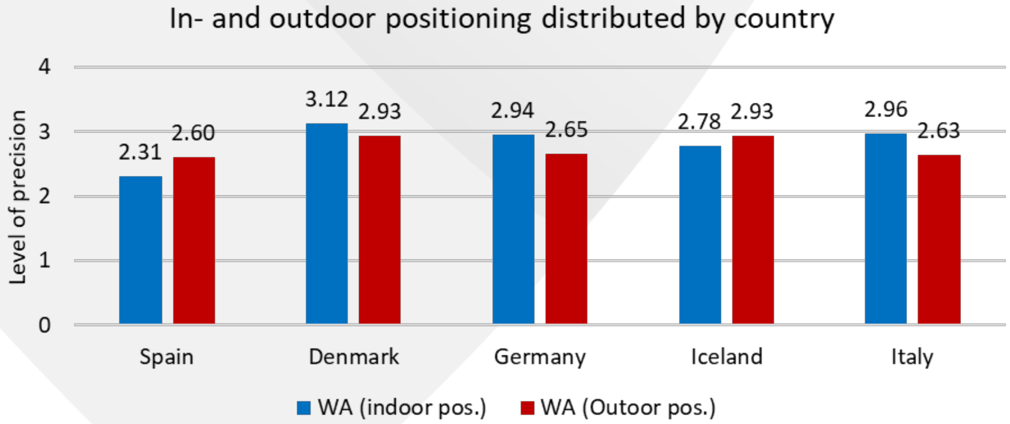


Figure 4 Comparison of in- and outdoor localisation by country.

There seems to be a tendency among the countries to have a WAs centred around a value of 3, which corresponds to a level of precision within 2m, disregarding horizontal and vertical dimensions as well as in- and outdoor conditions (Figure 4). As the general picture of positioning has shown, when comparing in- and outdoor, there may be a country-specific reasoning behind the values.

The level of vertical precision for in- and outdoors differs slightly (Figure 5), where vertical in- and outdoors require a precision within roughly 2m. The WAs vary more when comparing horizontal positioning in- and outdoors. According to the end-users, the indoor horizontal precision is required to be within 1m, whereas outdoor horizontal precision is required to be within 2m. In general, indoor localisation of CPETs requires a more accurate positioning than outdoor conditions. Precision requirements for outdoor horizontal and vertical conditions are similar.

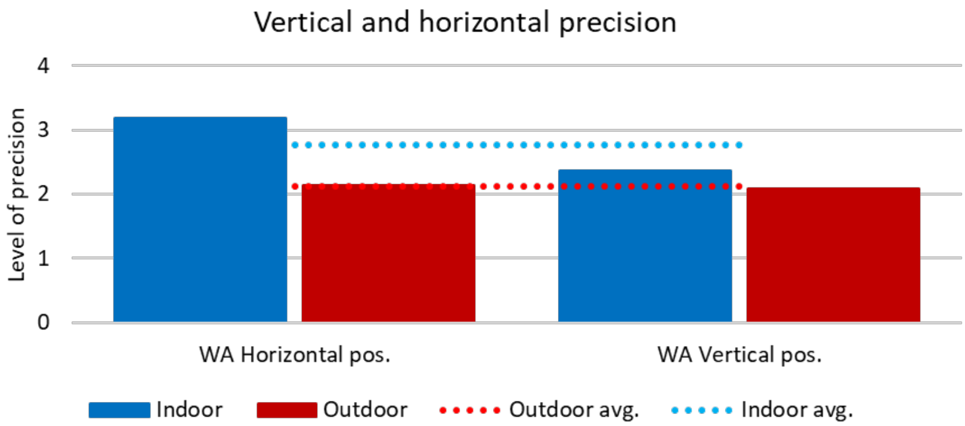


Figure 5 Comparison of WA mean values for horizontal and vertical in- and outdoor positioning.

It may appear that the preferred precision depends on the in- and outdoor context. In the context of urban search and rescue, indoor positioning is required by the Italian interviewee to be accurate both horizontally and vertically. According to the Spanish interviewee, horizontal indoor positioning is required to be as accurate as possible due to impaired visibility. The same precise precision applies to outdoor horizontal positioning within in a Spanish context. Vertical indoor positioning is required by all interviewees to be as accurate as possible. However, the German interviewee requires a less precise horizontal indoor positioning, whereas vertical indoor positioning is more relevant in a German context.

Based on the survey results and interviews divided by nationality, the following list includes country-specific requirements, which correspond to UR12_pos.

Spain requires:

- Survey results: (i) vertical indoor: <10m; (ii) horizontal indoor: <10m; (iii) vertical outdoor: <10m; (iv) horizontal outdoor: <10m
- Interview requirement: There appears to be a need of a very precise horizontal and vertical indoor location. Furthermore, an exact horizontal outdoor positioning is required, especially during night-time
    - The survey results and the interview conflict with one another

Denmark requires:

- Survey results: (i) vertical indoor: <5m; (ii) horizontal indoor: <5m; (iii) vertical outdoor: <5m; (iv) horizontal outdoor: <5m
- Interview requirement: <5m horizontal outdoor localisation and <1m vertical indoor positioning
    - The survey results and the interview conflict with one another

Germany requires:

- Survey results: (i) vertical indoor: <5m; (ii) horizontal indoor: <2m; (iii) vertical outdoor: <5m; (iv) horizontal outdoor: <10m
- Interview requirement: Vertical and horizontal outdoor positioning is not relevant. <5m horizontal indoor localisation, whereas vertical indoor localisation should be <1–2m
    - The survey results and the interview conflict with one another

Iceland requires:

- Survey results: (i) vertical indoor: <10m; (ii) horizontal indoor: <5m; (iii) vertical outdoor: <5m; (iv) horizontal outdoor: <5m
- Interview requirement: Vertical and horizontal indoor location i.e. cave rescue or building fire is required a precision of <1m. Horizontal outdoor positioning is required to be <10m
    - The survey results and the interview conflict with one another

Italy requires:

- Survey results: (i) vertical indoor: <5m; (ii) horizontal indoor: <2m; (iii) vertical outdoor: <10m; (iv) horizontal outdoor: <10m
- Interview requirement: Indoor positioning is required to be very precise when dealing with complex search and rescue missions, e.g. the shipwreck of the Costa Concordia in 2012, whereas in the context of seismic events there are no positioning requirements. Horizontal outdoor localisation is required to be <10m. Vertical outdoor location is not relevant
    - The survey results and the interview conflict with one another

Even though the survey and interview results may be conflicting and therefore require more in-depth evaluation, the general results indicate a high level of importance of geo-localising CPETs amongst the respondents. There appears to be a tendency for the qualitative interviews to reveal a desire for more accurate positioning than as derived from the survey results.

Data frequency and autonomy

Based on the survey results determining the importance of having positioning data transmitted three times an hour or real-time, the respondents appear to prefer real-time and view it as very important for both in- and outdoors. This corresponds to UR8_pos, for which the priority is considered high. UR14_pos is indirectly evaluated in UR8_pos, since real-time transmission of data requires a system that can provide geo-localisation for at least 30 minutes.

Hardware specifications

According to the survey results, it appears that the IOPES device is required by all respondents to be temperature resistant within a range of -10°C to +100°C. Temperature resistance corresponds to UR11_pos, for which the results indicate that the respondents find it important both in- and outdoors. UR11_pos is given a high priority. Additionally, weight and size of the sensor and tracker device are considered as important, corresponding to UR9_pos and UR10_pos having high priorities. According to the interviewees, the sensor should be as invisible as possible. By contrast, the tracker may have different sizes according to data from the interviews. There are two preferred sizes amongst the interviewees: (i) a tablet and (ii) a large pager. In compliance with the size, the functionality range is provided as well. The interviewees interested in a tablet were very supportive of having images and photos transmitted from sensors, the RPAS, etc. to the tablet-sized IOPES device. On the other hand, the interviewees mostly interested in a large pager-sized IOPES device were less interested in having access to photos and videos.

The overall level of value relating to hardware functionalities and specifications are in general considered important by the end-users. Functions such as the device being waterproof, manageable with gloves, night visibility and light-weight are ranked rather high among the respondents, whereas a touch screen or physical buttons are less important. Italy ranks waterproof, manageable with gloves and physical buttons as very important in- and outdoors, which is also supported by the Italian interviewee, stating how necessary large physical and user-friendly buttons would be. According to the Icelandic and Italian interviewees, the device should be robust enough to handle shocks and drops if used in a search and rescue operation.

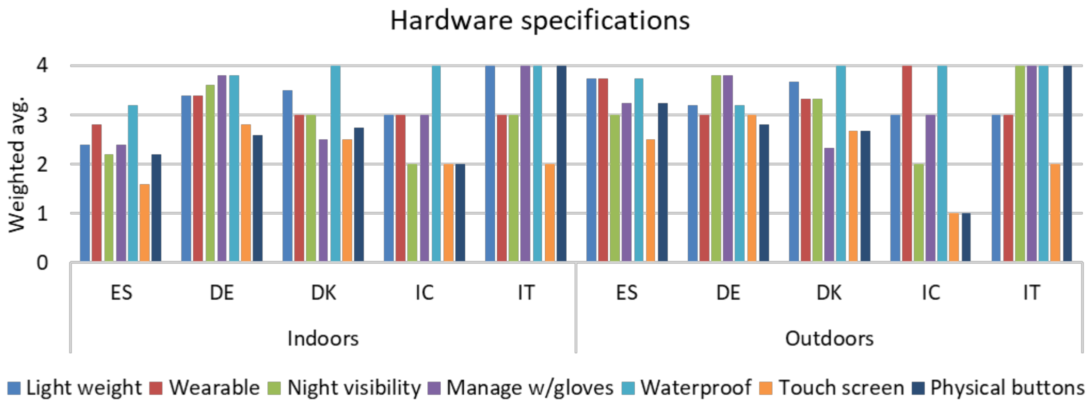


Figure 6 WA results on hardware specifications divided by country.

When evaluating the hardware specifications and functionalities (Figure 6), the results appear to be very different across the countries. Furthermore, the Icelandic and Italian interviewees preferred a simple device with fewer buttons and functionalities, though based on complex software engineering. The robustness of the technology was important, since in the context of search and rescue, e.g. in cave rescues, shipwrecks and building collapses, the IOPES device would have to be resistant to shocks, dust, moisture, etc. On the other hand, the German and Spanish interviewees considered having an additional fireman operating the IOPES device and providing the team leader or incident commander with relevant information. In such case, the IOPES device could be the size of a tablet and allow for several types of information and functionalities.

Technology confidence
Based on the interviewees, there appears to be consensus on a lack of confidence regarding the reliability of the IOPES system. As the Icelandic interviewee stated, the device should not try to replace already existing and well-functioning technology, e.g. mobile phones or the TETRA system, due to the risk of not updating or not keeping track of research and development. The Spanish interviewee referred to a concern of being reliable on technology hence risking ignoring inherent intuition as well as loosing manual skills.

As the current analysis focuses on the end-users' needs, the degree of confidence is in this context interpreted as a matter of trust in the technology. Based on the belief that technological support is common within the modern CPE management as well as the remarks from the end-users, it is assumed that UR13_pos is considered to be a concern. Based on this, the level of priority assigned to UR13_pos is medium.

3.2.2. User Requirement Priorities

Compared to the other types of requirements, the positioning requirements are limited, though they nevertheless comprise in- and outdoor variables including horizontal and vertical perspectives. The UR# with a (*) symbol requires more attention and possible variation according to nationality.

UR#_code	**Requirement description**	**Priority** low/medium/high
UR8_pos	Autonomy of in- and outdoor positioning	High
UR9_pos	The sensor should be as small as possible, and not disturb the normal motion of the firefighter	High
UR10_pos	Lightweight, portable, wearable and user-friendly geo-localisation device	High
UR11_pos	Working temperature between -10°C to +100°C	High
UR12_pos	Geo-localisation of emergency teams during operation	High*
UR13_pos	Provide degree of confidence about indoor/outdoor geo-localisation	Medium
UR14_pos	Capacity to provide reliable indoor/outdoor geo-localisation for at least 30 minutes	High

Table 5 End-user requirements (positioning) with assigned priorities.

It appears that vertical positioning in general is most relevant indoors, e.g. building fires, search and rescue and cave rescue, while, the importance of precise horizontal positioning showed a differentiation amongst the countries. The qualitative interviews revealed a requirement for more accurate localisation than the survey results provided. Moreover, the interviews uncovered alternative arguments for why the precision should change depending on the context.

Extracts from Interviews

Spain

Based on a previous forest fire in Spain, where members of the CPET died after being untraceable for hours, a system capable of geo-localising the CPETs would have made a difference. Due to the incident, all members of Spanish CPETs carry a radio that allows GPS transmission. Another example was a structural fire, where a roof collapse trapped two members of a Spanish CPET and a search and rescue team was unable to access the building due to the high temperatures, and for several minutes the CPE management was unaware of the location of the two team members.

Iceland

Based on experience, the Icelandic interviewee believes that indoor positioning of CPETs requires a high level of precision due to impaired visibility including the likelihood of having team members crawling, thus receiving direction solely through radio. Indoor conditions are likely to be affected by constant noise which prevents vocal directions, whereas in outdoor environments where visibility may also be impaired, e.g. due to a blizzard, vocal direction may possibly be adequate. Therefore, outdoor positioning in the Icelandic context requires less precise localisation.

In addition, the Icelandic interviewee recommended a satellite tracker by Garmin – a simple device that would provide limited information, however it could connect to a mobile telephone where communication through the tracker is possible.

Italy

Based on a previous search and rescue mission related to the shipwrecked Costa Concordia cruise ship (2012), the Italian interviewee was able to report that communication between CPETs onboard and the offsite CPE management was almost non-existing. In addition, the location of CPETs was not known during significant periods of the mission. A device capable of positioning CPET members inside the Costa Concordia, i.e. with barriers such as iron, water and movement, would have greatly supported the decision-making.

3.3. Emergency Management Systems

The Emergency Management System (EMS) is a reference to the current IT-based communication system adopted in most CPE organisations. The EMS allows the local, regional and national control centre to communicate both on- and offsite. In the scope of the IOPES project, an enhancement of the EMS is evaluated to involve data transmission, collection, storage and display. The data collected can be used for future segmentation of behavioural data of CPETs, combining variables, e.g. time and positioning and performing a post-mortem analysis, thus improving emergency management.

The following list presents the survey questions related to emergency management systems:

- How important is transmission of data (geo-localisation data) to the emergency management system?
- How important is it for you to store the geo-localisations of emergency teams (allowing you to backtrack their activities in minutes)?
- How important is it to have a fast setup of the device during an emergency?
- What is the ideal setup time for such a device during an emergency? (i) 1 min; (ii) 2 min; (iii) 3 min; (iv) 4 min; or (v) 5 min
- How important is it for you to geo-localise specific findings during the emergency, such as firemen detecting injured and deceased individuals, as well as hazardous materials and similar, that the team leader/incident commander needs to know of?
- How important is it to you that during the incident the device allows multiple users to gain access and use it as a collaborative platform? (i) Emergency teams from own district; (ii) Emergency teams from other districts; (iii) Police; (iv) Health teams; (v) Military; and (vi) Non-Governmental Organisations
- How important is it to you that the device allows you to identify road obstructions or environmental obstacles that interfere with the operation?

The current subsection presents an overview of the end-user's requirements related to the collection, usage and storage of time-tagged information, including an evaluation of shared situational awareness.

3.3.1. Results

Based on the survey, the respondents appear to be in agreement regardless of country origin, though Iceland's WA is rather low for two survey questions, which results in a lower mean value (Figure 7). It appears that the countries value the importance of most of the EMS requirements fairly highly.

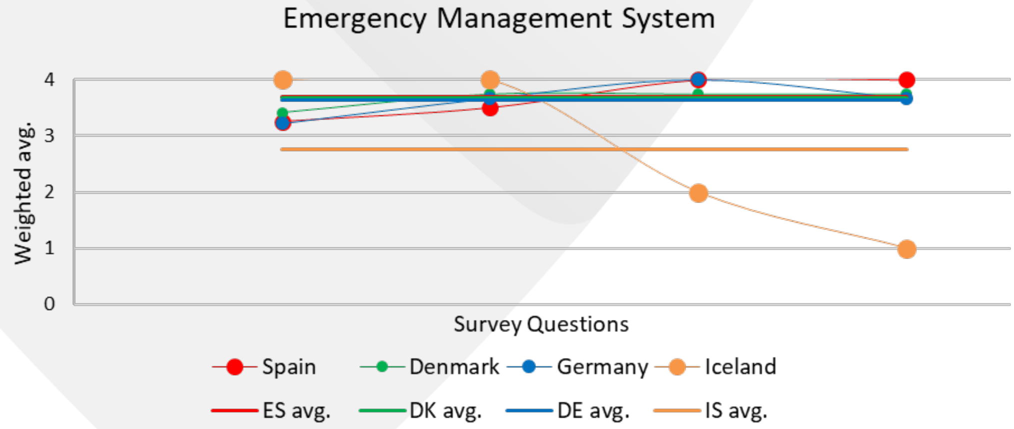


Figure 7 WA results for EMS survey questions distributed by country.

Spain, Denmark and Germany have a mean WA within the top end of the scale, corresponding to a range of *important* to *very important*.

Shared platform

There appears to be consensus regarding the sharing of the IOPES platform with CPETs within their own district, however the level of importance decreases when evaluating the possibility of sharing the platform with external district CPETs (Figure 8). This corresponds to UR22_ems and UR23_ems.

Figure 8 WA results for the importance of giving access to stakeholders divided by countries.

Regarding haring the platform with police, the countries retain a certain level of consensus, where the general assessment is that it is *important*. Spain, Denmark and Germany accord a high level of importance to sharing the platform with health teams, though Iceland finds it less important. Military institutions and non-governmental organisations (NGOs) are found to be less important, and for Iceland not important at all. In general, it appears that allowing access to relevant stakeholders is important, however there may be cultural and communicational differences in national CPE management that makes a possible platform collaboration with certain stakeholders inappropriate. Due to diversity in national CPE procedures in terms of platform sharing, the assigned priority for UR22_ems and UR23_ems are both considered high, thus they both need further and possible varied accessibility.

Information fusion and load
On the other hand, collection and storage of all information in one system available to the incident commander or team leader may result in information overload. Based on the survey results, the respondents value the importance of access to social media, a browser and weather forecasts through the IOPES device fairly highly. Figure 9 illustrates how Iceland differs from the other three countries.

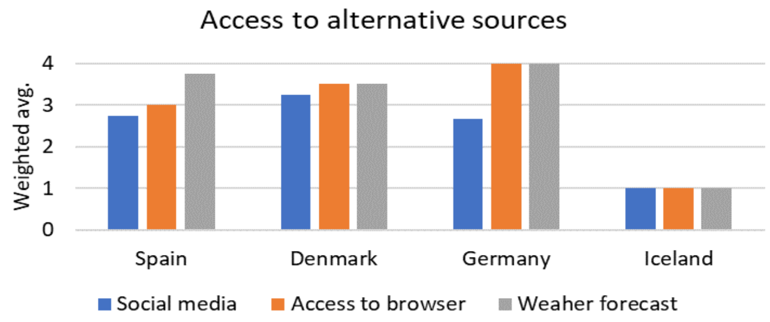


Figure 9 WA results of having access to open-source internet divided by country.

According to the interview, the Icelandic interviewee prefers to use already existing technologies such as tablets, computers and telephones if requiring access to the internet. The qualitative interviews from Spain and Germany revealed that this kind of information is commonly provided by the EMS/control centre or police authorities. The survey and interview may conflict regarding the relevance of providing internet access, and this may thus require further assessment.

The qualitative interviews revealed that information overload is a concern for some interviewees. In particular, the Danish and German interviewees preferred less information due to the risk of information overload which may interfere with decision-making, whereas the Icelandic and Spanish interviewees preferred to self-regulate. It is assumed, however, that the perception of information overload is not necessarily country-related but is rather individually based. The evaluation of information overload and fusion corresponds to UR15_ems, which is considered a high priority due to conflicting preferences.

Visualisation of CPETs
Regarding visualisation and management of CPETs corresponding to UR16_ems, most of the respondents appear to value the importance of doing so. The Icelandic, German, Spanish and Danish interviewees appear to find visual positioning of vehicles and CPETs highly relevant for even smaller incidents, in order to ensure a quick and appropriate operation. The Italian interviewee prefers to use the IOPES system during rare incidents such as the Costa Concordia shipwreck or after severe earthquakes, and not necessarily during routine operations. The priority of UR16_ems is evaluated as being high.

Data storage

Based on the survey results, there seems to be consensus regarding the importance of data storage of CPETs behaviour, which relates to UR20_ems and UR21_ems. The qualitative interviews revealed that the data may be used for debriefing and to develop future exercises to enhance the CPE operation. All interviewees recognised a high level of relevance for using the data when debriefing. Furthermore, the Danish and Spanish interviewees mentioned accountability challenges, including insurance, which may evolve if this novel data source was implemented. Both the Spanish and Danish interviewees weighed the safety of the CPETs higher than accountability issues.

3.3.2. User Requirement Priorities

All UR#_ems are assigned high priorities, however there are a few URs that require variation if further proceeded with due to national differences, i.e. UR15_ems, UR22_ems and UR23_ems. The UR# with a (*) symbol requires more attention and possible variation according to nationality.

UR#_code	**Requirement description**	**Priority** low/medium/high
UR15_ems	Real-time data and information fusion to support incident commander decision-making	High*
UR16_ems	Visualisation and management of simultaneously tracked emergency members	High
UR20_ems	History (memory) of team members' geo-localisations	High
UR21_ems	Storage of conversations and geo-localisations for post-mortem analysis	High
UR22_ems	Collaborative platform allowing multiple users to use it at the same time	High*
UR23_ems	Share situational awareness to provide advance notice of resource needs of multiple stakeholders	High*

Table 6 End-user requirements (EMS) with assigned priorities.

Extracts from Interviews

Spain
All onsite requests for personnel and vehicles were communicated from onsite incident command through the control centre, i.e. EMS. No direct onsite communication occurs between CPE members and stakeholders, e.g. police.

Italy
All communication with the police goes through the operational room, i.e. EMS. The interviewee believes that a system shared with other emergency forces including the onsite police will improve situational awareness.

Germany
Based on experience with the Berlin fire department, the device implemented to support situational awareness during an incident is the tablet application "FireApp". The German interviewee recommended the application due to a very user-friendly design.

3.4. Communication Systems

The IOPES system is an information system where types of data are transmitted through a communication channel. In the context of IOPES, communication-related requirements include the importance of information types, communication channels, frequency of information and communication procedures.

The following list presents the survey questions related to communications:

- How important is it to you that you can visualise and track emergency teams using this device?
- How important is it to you that the communication system does not rely on civil infrastructure?
- How important is information (video and photos) provided to you by drones (RPAS) during an incident? (i) Video; (ii) Photo; and (iii) Video and photo
- How important is it to you that the device allows you to communicate in multiple ways? (i) Voice; (ii) Photo, (iii) Text; and (iv) Video
- How much delay in the following types of communication is acceptable for you during an incident? (i) Voice; (ii) Photo, (iii) Text; and (iv) Video
- How important is it to you to share information obtained from the device with other national agencies or EU states? (i) Voice; (ii) Photo, (iii) Text; and (iv) Video
- How important is it to you that the device can access information from various sources such as social media, weather forecasts and traffic reports to support situational awareness? (i) Social media; (ii) Access to browser; and (iii) Weather forecast
- How important is it to you to have updated cartography information during an incident?

3.4.1. Results

Except for a few singular WA results, the countries seem to agree on prioritising requirements related to communication systems (Figure 10).

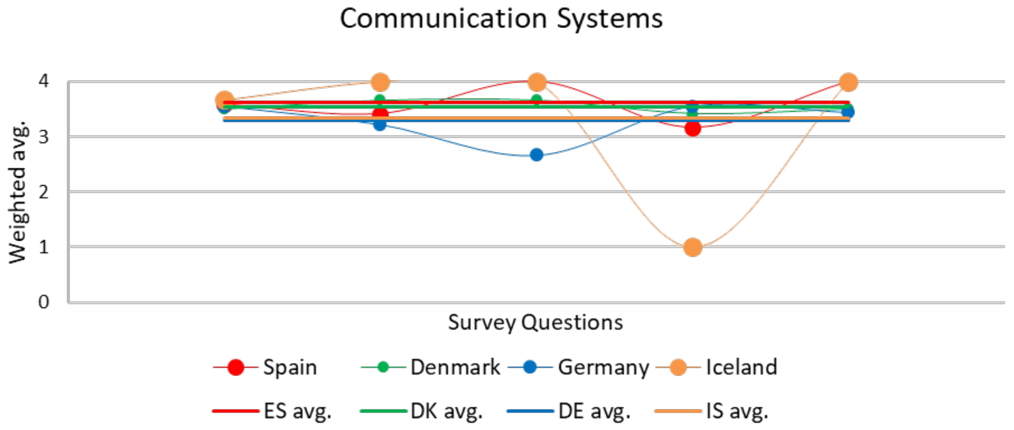


Figure 10 WA results for survey questions divided by country.

Information frequency

According to the respondents, the general requirement is that there should be a minimum of delay for all types of communication. This relates to UR32_com, which is given a high priority.

Information type

Based solely on the survey results, the respondents value the importance of voice and video highest and text and photos less. On average, the level of importance is considered *less important*.

The Icelandic interviewee, and to some extend the Italian, require a simple system providing geo-positioning, whereas the Danish, German and Spanish interviewees require a device capable of providing multiple types of information. In general, data transmission from the sensor carried by CPET members to the IOPES device carried by the CPE decision-maker is evaluated as being important. However, when viewing the results distributed according to nationalities (Figure 11), there appears to be a difference between the type of information required to be communicated. Though Iceland does not find the communication type and channel important, the other three share a similar need for the CPET member to send GPS coordinates, photos, videos and to some extend audio and texts. This corresponds to UR29_com having a high priority and UR31_com having a medium priority.

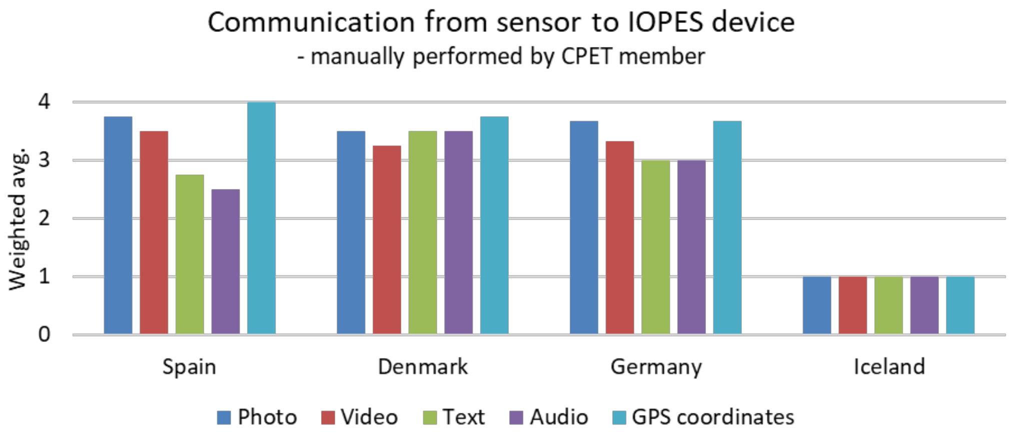


Figure 11 WA results for communication from sensor to IOPES device.

Communication procedures

As the Danish and German interviewees mentioned, if the setup of a CPE device is time consuming, it will most likely not be used. The setup time corresponds to UR26_com and is assessed by the end-users to be within one to two minutes. In accordance with all the interviewees, the setup time is required to be instant, which is equivalent to a high priority.

The respondents agree that the communication system must be independent from civil infrastructure, since the infrastructure is commonly damaged during large incidents. This corresponds to UR27_com being assigned a high priority.

Communication channels

UR24_com is comparable to UR23_ems, where accessing alternative sources such as open-source information, i.e. social media, weather forecasts and an internet browser. With reference to Figure 9, UR24_com is considered to be of high importance, with further assessment of individual-based preference on information load.

There appears to be a modest consensus amongst the respondents of EU states being allowed access to the IOPES system, for which UR34_com is considered having a high priority.

UR35_com shares similarities with UR23_ems, where the requirement addresses the need to share the IOPES platform. It may be that the two URs are interconnected. If access to the IOPES system is given to other stakeholders, this access would have to be properly differentiated according to the user. The UR35_com is assigned a high priority.

3.4.2. User Requirement Priorities

In brief, the communication-related requirements are prioritised rather highly, requiring several types of information without a time delay and possibly shared with relevant stakeholders.

One of the interesting findings relates to communication procedures within the CPE organisation, where horizontal communication refers to communication between equally ranked personnel and vertical communication refers to communication between different management levels. In CPE organisations there are communication procedures (also referred to as chain of command) that ensure a unified workflow despite numerous individuals being involved. The Danish and German interviewees mentioned that they relied on a formalised communication between the CPE and police management onsite during an incident, by which information not provided by the EMS can be provided by the police, e.g. road obstructions and public activities. The Spanish and Italian interviewees do not communicate directly with the police onsite, instead the communication occurs through the EMS.

The UR# with a (*) symbol requires more attention and possible variation according to nationality.

UR#_code	**Requirement description**	**Priority** low/medium/high
UR24_com	Capability to visualise data from various sources to have situational awareness	High*
UR26_com	The user shall be able to rapidly set up communications means in disaster areas	High
UR27_com	Need to have reliable communications independent of civil infrastructures	High
UR29_com	Capability to send data and voice, overcoming limitations of TETRA systems regarding data rate transmission	High*
UR31_com	Need to have multiple voice and video to have conversations over the communications network	Medium
UR32_com	Need to have low latency communications	High
UR34_com	Users from at least the EU countries shall be able to use the system	High
UR35_com	Capacity to determine what information should be shared or seen by other actors/agencies	High

Table 7 End-user requirements (communication) with assigned priorities.

Extracts from Interviews

Spain, Iceland, Italy
Manually assigned geo-localisation of the CPET members is preferably provided verbally through the TETRA system, from the CPET member to the decision-maker, where the decision-maker manually inserts the positioning.

Italy
The Italian interviewee prefers to communicate verbally with CPETs by using a radio, i.e. the TETRA and IOPES systems.

4. Concluding remarks

Most of the 31 user requirements are considered by the end-users as important and very important, and therefore given a high priority. In the analysis a few URs were found to require further evaluation based on significant differences between countries. The URs with a (*) symbol require more attention and possible variation according to nationality.

UR	Requirement description	Priority low/medium/high
UR1_map	Device shall be operable in daylight and at night in all weather	High
UR2_map	Need to have imagery and live video from RPAS during the whole emergency (day and night period)	Medium
UR3_map	Provide information from victims, affected people, goods, and/or geo-localisation	High
UR4_map	The system shall provide detailed imagery of the damaged structure	High
UR5_map	The user shall be able to detect flood events, damaged areas, traffic jams and road obstructions using information provided by the RPAS	Medium
UR6_map	Capacity to be operational with few hours of daylight per day	High
UR7_map	The user in the field shall be able to feed the system with geo-localised pictures and/or reports from the affected area	High
UR18_map	Capability to load critical assets/infrastructures maps	High
UR19_map	Need to have high resolution cartography produced very quickly soon after a disaster	High
UR30_map	Capability to load and visualise updated cartography	High
UR8_pos	Autonomy of indoor/outdoor positioning	High
UR9_pos	The sensor should be as small as possible, and not disturb the normal motion of the firefighter	High
UR10_pos	Lightweight, portable, wearable and user-friendly geo-localisation device	High
UR11_pos	Working temperature between -10°C and +100°C	High
UR12_pos	Geo-localisation of emergency teams during operation	High*
UR13_pos	Provide degree of confidence about indoor/outdoor geo-localisation	Medium
UR14_pos	Capacity to provide reliable indoor/outdoor geo-localisation for at least 30 minutes	High
UR15_ems	Real-time data and information fusion to support incident commander decision-making	High*
UR16_ems	Visualisation and management of simultaneously tracked emergency members	High
UR20_ems	History (memory) of team members' geo-localisations	High
UR21_ems	Storage of conversations and geo-localisations for post-mortem analysis	High

UR22_ems	Collaborative platform allowing multiple users to use it at the same time	High*
UR23_ems	Share situational awareness to provide advance notice of resource needs of multiple stakeholders	High*
UR24_com	Capability to visualise data from various sources to have situational awareness	High*
UR26_com	The user shall be able to rapidly set up communications means in disaster areas	High
UR27_com	Need to have reliable communications independent of civil infrastructure	High
UR29_com	Capability to send data and voice, overcoming limitations of TETRA systems regarding data rate transmission	High*
UR31_com	Need to have multiple voice and video to have conversations over the communications network	Medium
UR32_com	Need to have low latency communications	High
UR34_com	Users from at least the EU countries shall be able to use the system	High
UR35_com	Capacity to determine what information should be shared or seen by other actors/agencies	High

Table 8 All end-user requirements priorities.

In general, the analysis shows a tendency for the end-users' requirements to be rather reliant on the given nationality of the respondents. Most of the user requirements are highly prioritised, though there are a few URs that require a country-specified evaluation which the current study cannot provide, due to the number of respondents. The present section introduces a review of the most interesting findings in the analysis, including additional inputs revealed in the survey and interviews.

Fast mapping and visual information appear important to the end-users, particularly to Denmark, Spain, Germany and Italy, though not to Iceland. The RPAS is not yet a common technology in most countries, though they have started its implementation. Having the IOPES device communicate with the RPAS appears to be a high priority for most. In general, interoperability with existing technologies is appealing to all interviewees. Moreover, having the IOPES device replace the TETRA system, existing GPS trackers, thermo cameras and the like, appears interesting for some interviewees, though it is not a common phenomenon.

There appears to be consensus on having a system that is customised to the end-user for their specific management level, e.g. the team leader requires information of the CPET members visualised as dots on a local map, while the incident commander may require the position of the team leader as well as the CPETs, though in a larger map including access routes, etc. Offsite, the CPE control centre may require the positioning data in GPS coordinates in order to run statistics or to request further support in the form of vehicles and CPETs. In the context of an incident forcing the regional or national control centre to be activated, such users may require a different set of information. It is recommended that a further evaluation of the user-interface possibilities of the IOPES system be performed before implementation.

The current user analysis shows that the requirements relating to information sharing and multiple users engaging with the IOPES platform may differ according to national CPE procedures. Having a platform where the police have access to certain information may be appropriate in some countries, whereas in others it will not be. In some countries, digital information can be relevant to share onsite directly through the IOPES system, while in other countries where the onsite communication is directly between the CPE manager and the police, digital information sharing may be irrelevant or even disturb the current communication procedure. Different traditions and communication procedures may impact the software specifications, such as interoperability and the capability of sharing the platform. In Denmark, Germany and Iceland, the CPE management collaborate closely and directly with the police onsite, whereas in Spain and Italy the collaboration occurs offsite through the EMS control centre.

Additionally, the interviews revealed an interest amongst the interviewees to use the positioning information when debriefing and for future exercise optimisation. There appears to be consensus amongst the interviewees regarding the potential learning aspects which positioning data would provide the CPE organisations.

Accountability would be an obvious concern when having group and person-specific data stored, in terms of certain activities with a risk of enormous financial losses, however this concern was only briefly touched on by a few interviewees.

Last but not least, the collection of user requirements is an ongoing action that will continue during the project lifetime. Project exercises will serve to collect participants (users) feedback that in turn will be converted into system requirements; a second End-User workshop (scheduled for January 2021) might serve to identify new requirements; and meetings with additional CPET from different countries will be arranged to gain insight into specific features or functionalities of the IOPES system.

Reference Documents

RD1] IOPES – Grant Agreement (GA) – GA 874391.
[RD2] IOPES – Consortium Agreement (CA) – Version 1.0.
[RD3] Union Civil Protection Mechanism. Prevention and Preparedness Projects in Civil Protection and Marine Pollution. Call for proposals document UCPM-2019-PP-AG - Version 1.0.

Reference

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Related Projects

H2020 Heimdall (Multi-Hazard Cooperative Management Tool for Data Exchange, Response Planning and Scenario Building), http://heimdall-h2020.eu/ *(accessed 28.04.2020)*

H2020 IN-PREP (An INtegrated next generation PREParedness programme for improving effective inter-organizational response capacity in complex environments of disasters and causes of crises), https://www.in-prep.eu/ *(accessed 28.04.2020)*

H2020 DRIVER+ (DRiving InnoVation in crisis management for European Resilience), http://driver-project.eu *(accessed 28.04.2020)*

H2020 BeAWARE (Enhancing decision support and management services in extreme weather climate events), https://beaware-project.eu/ *(accessed 28.04.2020)*

H2020 SAYSO (Standardization of situational Awareness sYstems to Strengthen Operations in civil protection), https://www.sayso-project.eu/ *(accessed 28.04.2020)*

H2020 EOPEN (opEn interOperable Platform for unified access and analysis of Earth observatioN data), https://eopen-project.eu/ *(accessed 28.04.2020)*

FP7 RECONASS (Reconstruction and REcovery Planning: Rapid and Continuously Updated COnstruction Damage, and Related Needs ASSessment), http://www.reconass.eu/ *(accessed 28.04.2020)*

H2020 AIOSAT (Autonomous Indoor Outdoor SafetyTracking system), http://www.aiosat.eu/ *(accessed 28.04.2020)*

H2020 iREACT (Improving Resilience to Emergencies through Advanced Cyber Technologies), http://project.i-react.eu/ *(accessed 28.04.2020)*

IOPES

Indoor-Outdoor Positioning
for Emergency Staff