BLUEPRINT OF USER EXPERIENCE AND INTERACTION FOR CRAMSS AND APPS

Project Title	RESOLUTE
Project number	653460
Deliverable number	D5.1
Version	11.1
State	Final
Confidentially Level	Public
WP contributing to the Deliverable	WP5
Contractual Date of Delivery	M14 (30/06/2016)
Finally approved by coordinator	04-08-2016
Actual Date of Delivery	M15 (03/08/2016)
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funded by the Horizon 2020
Framework Programme of the European Union

EXECUTIVE SUMMARY

During the course of the RESOLUTE project, two versions of the deliverable "Blue print of user experience and interaction for CRAMSS and Apps" are foreseen. This is the early version, submitted right at the beginning of work in WP5 (M14). The deliverable will be updated in M22, as changes may be necessary along the course of the work in WP5.

The final version will include descriptions of the work carried out in T5.1: The research of user requirements and the resulting user interaction concepts and designs for the three front-end applications to be developed in WP5:

- CRAMSS (Collaborative Resilience Assessment and Management Support System)
- Emergency support smart mobile app
- Game-based training app

The aim of this early version is to lay out which work is planned to be done in T5.1 and to provide a starting basis for the work in Tasks 5.2, 5.3, and 5.4. It collects key information that needs to be shared between all WP5 tasks, in order to ensure that the apps developed will fulfil their purposes, will be compatible to each other and their user interfaces will follow the same interaction logic, as far as reasonable, based on their interconnections. Moreover, the "blueprint" serves as a basis for the common user interaction design process, which was purposefully not integrated into each of the three application development tasks separately, yet altogether into one Task 5.1, to ensure the required link between the other subtasks.

These key aspects, as currently known can be summarised as follows:

- Target users and their characteristics
- Objectives of these users when using the applications
- Key features (as a synonym of "technical functionalities"), including contents
- Technical restrictions
- Approach and work plan for researching user requirements and developing the User Interfaces
- Overall User Interface structure, as currently planned and first sketches of the design.

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PROJECT CONTEXT

Workpackage	WP5: Platform front-end and end user applications
Task	T5.1: Interaction Design and user experience
Dependencies	Input for tasks 5.2, 5.3, and 5.4

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Version History

Version	Date	Authors	Sections Affected
01	17/5/2016	J. Leuteritz	All
02	30/5/2016	J. Leuteritz, V. Melcher	All
03	09/6/2016	J. Leuteritz, V. Melcher	All
04	20/6/2016	J. Leuteritz, V. Melcher	All
05	29/6/2016	J. Leuteritz, V. Melcher	All
06	03/7/2016	J. Leuteritz	All
07	25/7/2016	J. Leuteritz, V. Melcher	All
08	31/07/2016	J. Leuteritz, V. Melcher	All
1.0	03/08/2016	J. Leuteritz	Format corrections

11.1	04-08-2016	P. Nesi	All

Abbreviations

Abbreviation	Full term
ACD	Activity-Centred Design
CI	Critical Infrastructure
CRAMSS	Collaborative Resilience Assessment and Management Support System
ESSMA	Emergency Support smart mobile app
GBTA	Game-based Training app
GUI	Graphical User Interface
SAVE ME	System and actions for vehicles and transportation hubs to support disaster mitigation and evacuation (SAVE ME project; Grant Agreement No. 234027 of the European Commission)
UCD	User-Centred Design
UI	User Interface
UTS	Urban Transport System(s)
OS	Operating System

Gender writing statement

This deliverable contains gender-specific terms. Gender specific terms have been avoided where possible. Where not possible, the male and the female form were used at random, for reasons of shortness and readability. In all cases, it is assumed that the respective person could be of any gender.

Copyright Statement – Restricted Content

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1 INTRODUCTION

1.1 Scope and structure of T5.1 and this Deliverable

1.1.1 Scope of T5.1

T5.1 "Interaction Design and user experience" is focused on the three front-end applications to be developed in the RESOLUTE project:

- The T5.2 CRAMSS (Collaborative Resilience Assessment and Management Support System)
- The T5.3 ESSMA (Emergency Support smart mobile app)
- The T5.4 GBTA (Game-based Training app)

For these three applications, T5.1 will elaborate user requirements and develop and test user interaction concepts in the shape of storybooks, wireframes, graphics for elements such as icons, etc. These will be provided to the partners involved in the tasks developing the front-end applications. As the CRAMSS is currently planned to be not a single application but a rather a compound of different small applications, it might be necessary to provide a style-guide for these different applications, which will support the flexibility of the architecture and simplify the enhancement of the CRAMMS with new features once they become available.

User requirements will be collected separately for each application, based on the usability / user experience engineering approach chosen for this specific application. Apart from additional literature research, this approach is mainly based on focus-group discussions and interviews. The development will be based on traditional Human Factors (HF) and user centred design methods, enriched by a scenario-based approach and High Velocity Human Factors methods in the case of the CRAMSS. Once a primary interaction concept has been created, based on the desired functions and informational content of the respective application, representative users will test the application in a controlled laboratory setting. The results of the test will be used to further improve the design along the course of the development.

1.1.2 Structure of this Deliverable

This deliverable serves the purpose of providing a solid basis for the developments in T5.1. It defines the starting point of the work and a common ground for all partners involved in Work Packages 4 and 5 to harmonize efforts. Each application is described within its own chapter and each chapter mentions, to the extent that is currently possible, the following aspects related to the respective application:

1. An **introduction** about the application in order to describe it within its technical, organisational and social context.
2. The **target users** for whom the application is being designed. It defines and restricts the group of users whose needs are to be addressed in the design.
3. The **objectives** of the application. This refers to the goals the users will be able to achieve using the application. It describes the functionality of the application from a user's perspective, focussing on the starting situation (desire, problem) and the solution meant to be provided by the system.
4. The **features** of the application. This refers to the technical functionality of the application and describes it from a system perspective. When described on a conceptual level, objectives and features may look very similar. However, differences should appear with a growing degree of detail in the description, to be achieved over the course of this task. This will make sure that user objectives and technical functionality are always developed together and thus the user interaction concepts to be developed in parallel will be applicable. As far as appropriate, the description of the features includes information about the contents

of the application. The feature may or may not depend on the content. As an example: The feature is an interactive map – the contents are the positions of fire extinguishers on the map.

5. The resulting **user requirements**. Based on the specification of target users, objectives, features, and other sources such as literature research, relevant user requirements are briefly described that will be taken into account in the development.
6. The **technical restrictions**. This refers to factors related to the technological platforms used for the implementation and also the environmental factors which (possibly) limit the available options in user interface design. For example, if a mobile app is to be developed for Android devices, then respective style-guides should be heeded and certain interaction elements are preferable.
7. The **work plan** that has been defined to develop the user interaction concepts.
8. The user interaction **blueprint**, containing a first draft of what the user interfaces could look like, based on the currently known restrictions.

Starting the development based on objectives and features is necessary: as the developments in RESOLUTE are based on what is defined in the Description of Work (DoW) and other parts of the Grant Agreement, it is important to outline the capabilities of the technology envisioned before talking to users about preferences and requirements. Although the process of researching user needs has to be open to receiving user feedback that may contradict what was planned in the project proposal, the project aims defined in the DoW need to be heeded at the beginning.

1.1.3 Project background

All three WP5 applications are meant to support the resilience approach (D2.1) developed in the RESOLUTE project and specified in the ERMG (D3.5 and D3.7). This means that the applications shall contribute to the development of local adaptive capacities, namely by supporting the human actor with access to information that, on the one hand enhances her understanding of the relevant and wider operational status and requirements, and on the other hand, supports the management of local resources in alignment with or towards the adjustment of such operational status and requirements. The information to be provided to users should foremost take into account the contents of the ERMG, mainly in terms of the identification of critical operational interdependencies under various relevant operational contexts:

- The identification and acknowledgement by whom, when and under what conditions resources are to be supplied
- Ensuring a shared understanding of the types and levels of resource needs amongst all relevant stakeholders
- The identification of all relevant operation control and monitoring mechanisms

From the perspective of operations management and in line with the RESOLUTE perspective on resilience, guidance representing the four cornerstones of resilience (Hollnagel, 2011) should also be taken into account:

- ANTICIPATE: what to expect (address “potential long term threats, anticipate opportunities for changes in the system and identify resources of disruption and pressure and their consequences for the system”)
- MONITOR: what to look for (address “critical aspects by monitoring system and environment for what could become a threat in the immediate time frame”)
- RESPOND: what to do (address actual state; respond to regular or irregular disruptions)
- LEARN: what has happened (“corresponds to the ability to address the ‘factual’ by learning from experiences of both successes and failures”).

Another scheme of which actions are required to create resilience was presented by the National Research Council of the U.S.A (2012):

- PLAN
- ABSORB
- RECOVER
- ADAPT

WP 5 should ensure that both these similar models are supported by the end user applications. We will focus on the cornerstones named by Hollnagel (2011b), as the same taxonomy is used in the ERMG.

1.1.4 Relevant project objectives

The project's objectives and desired impacts are stated in the Grant Agreement (see GA, p. 155 f.). Some of them may, at least partially, be achieved through the WP5 front-end applications or depend to some extent on the realization of these applications. The following table sums up these project impacts that are deemed relevant for the work in WP5, clustering them to the four key actions necessary to create resilience.

Table 1: Project objectives related to WP5 actions

Cornerstone	Desired impact	WP5 actions to support this impact
ANTICIPATE	"Reducing cost and time for implementing resilience guidelines"	The CRAMSS needs to be usable in an efficient manner, requiring a minimum training time and effort for its users towards receiving and understanding the decision support provided. Minimum time and effort are also required when the system automatically assesses the UTS current and future resilience status.
MONITOR	"Move to a paperless mode of work"	This is achieved by providing the user interface of the CRAMSS with a feature to view past data and analyses, additionally to the functions focusing on resilience assessment and actual / real-time data.
RESPOND	"Drastically reduce the risks for citizens"	The ESSMA (Emergency Smart Mobile App) needs to be designed in a way that it is attractive to users – even before (major) disruptions happen. It also needs to be usable without requiring excessive training. Respective training needs to be provided through the training app in a way that makes it a fun activity. The ESSMA also needs to display only few relevant pieces of information in case of a disruption, in order to achieve effective and efficient adaption of behaviour by its respective users. The CRAMSS, which helps organize rescue work, also has to be designed for doing this task very efficiently (saving time and effort and reducing mistakes by the user) in emergency mode.
RESPOND	"Reduce the time for taking right decision"	Centring the design and evaluation of the CRAMSS's emergency mode user interface on efficiency while guaranteeing a low rate of errors committed by the user.
RESPOND	"Efficiency in resource allocation during the emergency"	Centring the design and evaluation of the CRAMSS's emergency mode user interface on efficiency, while ensuring that the system will list all available resources, display all locations / cases where resources are required and making it easy for the user to map these to each other.
RESPOND	"Make emergency services more user-friendly"	Achieving a level of usability above a defined threshold with the ESSMA. As evaluation data of most other relevant emergency apps are not available, the threshold has to be defined based on norms of the measurement instrument, or (if also not available) by expert choice. The interaction needs to particularly take the emergency situation into account, with its special Human Factors requirements.
RESPOND	"Increase communication with citizens and authority"	WP5 only has a limited opportunity to influence this. Providing CRAMSS and ESSMA with a usable front-end will provide one more means of communication, which will probably be used in emergency cases or disruptions only. Communication from citizens to the authorities is strengthened by the integration of the social networks crawler that informs the CRAMSS operators about relevant news.
RESPOND	"Ensure widespread	Although WP5 has no influence on the available number of emergency services it may help to maximize the output of a given capacity of emergency services by

Cornerstone	Desired impact	WP5 actions to support this impact
	accessibility of emergency services"	supporting an efficient deployment.
MONITOR / LEARN	"Make the resilience assessment and management process easier and effective"	In normal mode, the CRAMSS needs to provide detailed information on each resource relevant to the system's resilience (effectiveness), while not disregarding the efficiency requirement mentioned above. One way to achieve this may be to use something similar to a hypertext structure, in which the user can select the required level of detail, or even provide algorithms (WP4) to help jumping directly to the relevant level of detail when monitoring data on resources.
LEARN	"Establish coordination with all stakeholders involved in UTS resilience management"	The CRAMSS may provide different access rights to different registered users, so that all relevant stakeholders for the management of UTS resilience can access relevant real-time data and recorded data from past events, allowing them to draw conclusions on how to plan ahead or adapt after a critical event.

1.2 User Centred Design (UCD)

All application development within the RESOLUTE project will follow a user-centred approach. This means that future users of the RESOLUTE applications will be involved in every development process as far as possible.

It would be possible to place the RESOLUTE UI development model into the context of existing Human Factors or Ergonomics frameworks, such as activity theory (e.g., Kuuti, 1995). However, the framework is extensive and serves a lot of different research and application objectives. It may indeed be helpful in the context of the pilot tests – in order to investigate how the CRAMSS interacts with other technology and social or organizational operation conditions. For the development of the applications itself, this framework is less relevant. We will refer to the framework presented by Koffesky and Harvey (2015) when it comes to analysing user performance with the CRAMSS. The framework divides between three steps of human behaviour: sensing/perception, information processing, and physical/verbal responses. Valid and reliable measurement instruments for the single steps are available or can be adapted from the literature.

Following a user centred design process ensures that the applications and services will fulfil the requirements and needs of potential users in an appropriate way and leads to more usable systems and applications.

Involving users in every stage of the application development refers to the following stages:

- Requirements analysis: In this phase of the development process, the main users and stakeholders as well as their requirements regarding the application are identified. Within the requirement analysis the main "W" questions should be answered:

  WHO is going to use the application – in terms of the main users as well as secondary users?

  WHAT kind of functionality or "features" should the application have to enable the users to carry out their required tasks?

  WHICH hardware should be considered?

  WHERE are the users using the application – considering environmental facts like noise, heat, etc.

The outcome of the requirements analysis consists of a set of user specific requirements that build the basis for use case or user scenario descriptions, as well as feature specifications for the future RESOLUTE applications.

- Prototyping: A prototype is a draft version of an application, depending on the prototype level with no to full functionality range. Prototypes allow developers to explore the comprehensibility and the usability of the application in an early development stage.

  The prototypes may come in the shape of:

  - A series of drawings on paper or paper mock-ups (called a low-fidelity prototype),
  - A few screens of the application that the user can click through (for instance a click demo in Microsoft PowerPoint),
  - A complete implementation with full functionality (called a high-fidelity prototype).

  High-fidelity prototyping is a method in which the prototype used for testing mimics the actual interface as closely as possible. Usually, for software interfaces, another software tool is used to mock-up the interface. This software tool accepts input from the keyboard or mouse like the actual interface would, and responds to those events in the same way (displaying a particular window or message, changing state, etc.) in the same way the actual interface would respond.

  The advantages of low-fidelity prototypes are that they can be used in an early stage of the development process and that they aren't expensive in deployment. It is easier to test multiple alternatives of user interfaces with low-fidelity prototypes because they support a fast iteration of alternatives. High fidelity prototypes are more suitable for end periods of the development process. A high-fidelity prototype is close enough to a final product to be able to examine usability questions in detail and make strong conclusions about how behaviour will relate to use of the final product.

- Evaluation: Within the evaluation phase, the RESOLUTE prototypes will be tested to ensure that user requirements have been appropriately incorporated. The evaluation method depends on the prototype. The main focus of the evaluation will be on the usability of the application in terms of understandable wording and interaction as well as the user acceptance. Early evaluation phases will include laboratory testing to facilitate the simulation of application functionality. Environmental factors will be neglected. Application evaluation in progressed stages of the development should consider testing in the field, taking environmental aspects of the user interaction into account.

While Activity-centred design (ACD) focuses on the activities of the user to be realised using a piece of technology, User-centred design (UCD) puts an emphasis on the goals and objectives of the user (Saffer, 2010).

1.3 RESOLUTE User Interface development approach

1.3.1 Requirements related to the development approach

All development of user interfaces in the RESOLUTE project is principally oriented at the relevant international norms. This chapter briefly summarizes how the norms are taken into account.

1.3.1.1 CRAMSS

In the case of the CRAMSS, which is control room software, EN ISO 11064 is relevant. The following table sums up how the norm applied in the project:

Table 2 – EN ISO 11064 – Part 1

Standard / Requirement	RESOLUTE actions
User-oriented design	Representative users are involved in several phases of the design process.
Applying ergonomics	Relevant are only cognitive ergonomics – using design criteria to decrease error probability and mental workload. Physically stressful interactions are not expected with the CRAMSS.
Iterative development	By definition in the DoW, an iterative process is applied in RESOLUTE. Phase A and B are summed up in the user requirements analysis, C and D are the iterations to be tested and Phase E is the pilot test (WP6).
Situation analysis	The CRAMSS, apart from the functionalities for emergency evacuation, are not directed at specific situations. Thus, situation analysis does not require assessing system failures (which would be contrary to the concept of resilience). It thus comprises task analysis and interviews with operators.
Task analysis	Taking all possible action modes of all possible organizations into account that will be using the CRAMSS is not possible in the context of this project. Instead, task analysis will be focused on finding out which aspects of relevant tasks could interfere with the desired functioning and usage of the CRAMSS.
Error tolerance	The CRAMSS offers little option for false input. Its complexity results of the interactions of many possibly connected users. Errors can especially occur: - When a user enters an action message / event description for the other users - When priorities are being assigned to objectives The CRAMSS will allow other users to question possibly erroneous input and to the user to correct it whenever wanted. The system will then advise all users about the change.
User involvement	This is guaranteed through the requirements analysis and user testing.
Interdisciplinary development team	Psychologists, informatics experts and engineers are involved in the design process (apart from the users).
Documentation of ergonomic design principles	This is done in this very document

The design process defined in EN ISO 11064 –1 is not entirely applicable to the CRAMSS, which does not involve certain elements frequently found in control rooms (such as controls for valves, doors, etc.) and which follows a resilience approach rather than strict procedures. Although it has to fit into existing strict procedures, it mainly is an additional source of information to the users. An exception to this is the module for emergency evacuation.

1.3.1.2 ESSMA and GBTA

With respect to the mobile applications, other guidelines, such as platform-based recommendations are relevant.

An intuitive interaction with an application is essential for user acceptance. A user should be able to handle the application in accordance with the user's mental model of the application. To provide an intuitive and easy interaction, RESOLUTE applications need to consider the distinguishability of interactive and non-interactive areas, the size of interactive areas, latency for user actions, comprehensible UI text and labelling of controls, and a good information- and error management.

1.3.1.2.1 Distinguishability of interactive and non-interactive areas

A user interfaces can be divided into areas that are not offering any means of interaction to the user (plain text, status bar, inactive buttons, etc.), while other areas do offer such means of interaction (e.g., active buttons, text entry fields, drop down menus, check boxes, etc.). To provide an easy and intuitive interaction with RESOLUTE user interfaces it should be clearly distinguishable which areas are active and equipped with functionality and which areas are inactive and just provide information to the user.

The following guidelines apply for distinguishable user interface areas and elements (Microsoft, 2012):

- Interactive and non-interactive areas and elements should be distinguishable by its design (UR).
- For active areas like active UI elements a similar design should be used (UR):
  - Temporarily non-interactive operation elements should be greyed out and/or should not be elevated by means of 3-D-representation (readability of text on elements should be ensured),
  - Active areas: May be elevated by means of 3-D-representation,
  - Interactive text: Should be emphasised.
- For non-interactive areas like text or status information a similar design should be used (UR):
  - Non-interactive text: Do NOT use colours that are in other places used for hyperlinks. Do NOT underline text,
  - Non-interactive areas should have the window background colour.

1.3.1.2.2 Size of interactive areas

For users with limited mobility and for elderly people it is recommended to design interactive areas larger than their related UI element. This guideline especially applies to devices based on touch interaction (UR).

1.3.1.2.3 Information- and error-management

A good information and error management is crucial to give the user the feeling that he/she is in control of the system. Users need to be informed about the system status in a comprehensible way. Error- and information messages can be categorized into the following types:

- Information messages present general information to the user, like the progress of an system action (Gnome, 2008, 2012),
- Warning alerts warn users about the possible consequences of a requested action, report on the results of an action, if they may not be expected (for example, when only three of four selected files were successfully downloaded) or report on other types of unexpected situations such as system conditions (for example, when disk space is running low) (Gnome, 2008,2012).
- Error messages report system and application errors to the user (Gnome, 2008, 2012).
- Confirmation alerts ask the user a question, usually before being able to carry out a requested action. For example, if the user uses the backward navigation and the current page is a fill-in form actually not saved the systems asks to continue the requested action with the consequence of data loss or to abort the requested action (Gnome, 2008, 2012).
- Success alerts indicate that an action has completed successfully (for example, a successful data down- or upload) (Gnome, 2008, 2012).

1.3.1.2.4 Latency of user actions

Response time to user action is an important aspect of usability. If the user has the feeling, that the application is not or very slowly reacting, or is reacting too fast to be handled, then the user might stop using this application.
The following guidelines are recommended:

- For response time below one second no progress information is needed (Nielsen Norman Group, 2013).
- Response to user actions should be immediate (UR).
- Even if long response times should be avoided, responses shouldn't come up too fast, the user should perceive the changes in the user interface and should have the possibility to react to changes (e.g. for scrolling) (Nielsen Norman Group 2013).
- If the response time is more than one second the user should be informed (Apple, 2012).

- For lengthy operation a progress indicator should be provided to inform the user how long the operation will take (Apple, 2012).

1.3.2 RESOLUTE UI development model

The overall user interaction approach in RESOLUTE is aimed at supporting the users by providing content through "*enhanced visualizations and other multimodal means, including speech, vibration, automated phone calls, as well as indirect environment-enabled guidance (e.g. traffic lights guidance)*" (GA, p. 151).

The different user groups addressed by the three applications impose a variety of Human Factors requirements on the development. These requirements are described in the respective chapters below in conjunction with each user group.

As represented in Figure 1, relevant information gathered in laboratory testing during the user interaction development process will be fed back to the ERMG development process. This is aimed at further improving the ERMG where necessary between M30 and 36. The outcomes of WP5 work are required for the successful realization of the pilot tests.

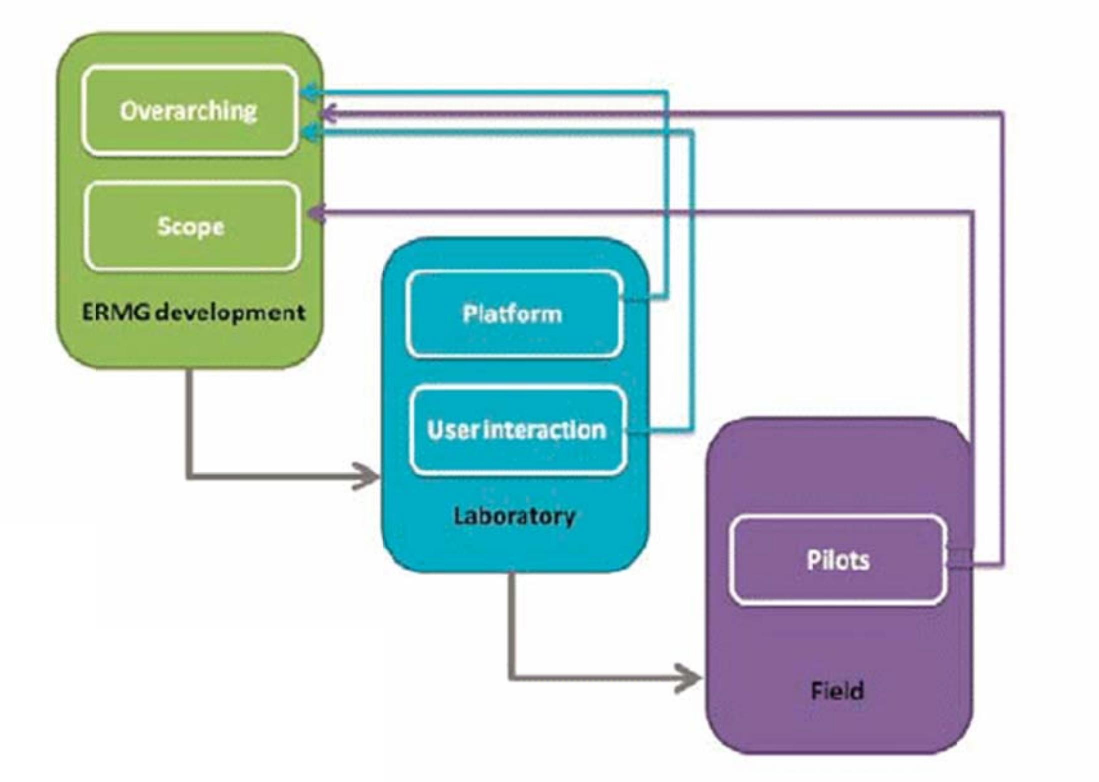

Figure 1. Visualization of the overall usability engineering approach (GA, p. 167)

The RESOLUTE iterative development approach will consist of two iterations.

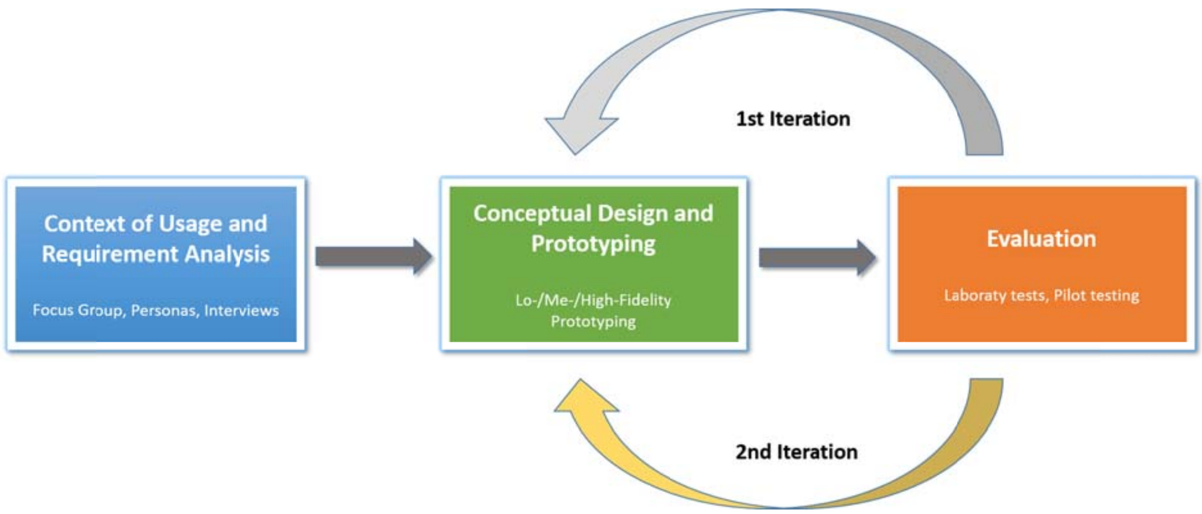

Figure 2: Detailed view of the front-end development approach in RESOLUTE

Iterative development of user interfaces involves steady refinement of the design based on user testing and other evaluation methods. Problems encountered by several test users while using it can then be fixed in a new iteration. The resulting design or prototype should then be re-tested to ensure that the problems of the first iteration are now solved and to find any new usability problems introduced by the changed design. Based on the requirements described in this document, materials are created, such as instructional guides for focus group discussions, in order to finalise the requirement analysis. For example, focus groups could serve to prioritise functions or objectives described below, which are then highlighted in the final user interface. Based on the requirements collected, low- or medium-fidelity prototypes of the different applications will be produced and tested in the laboratory with end users. The feedback collected here is used to refine the prototypes, which after that go into a second round of testing.

1.3.3 RESOLUTE UCD methods

The following tables describe recommended methods for the different stages of the application development process within RESOLUTE. Table 3 describes the most relevant methods available for requirements analyses and briefly summarizes their pros and cons, which lead to the decisions described below. Thus, these methods refer to the box on the left in Figure 2. Similarly, Table 4 lists the methods available for prototyping, which corresponds to the central box in Figure 2. Generally, the lower fidelity prototypes are adequate for early stages of design, and the more elaborated prototypes for final evaluations. The last box in Figure 2 is represented by Table 5, containing possible evaluation methods to choose from.

Table 3: Requirements analysis

Method	Description
Focus group	Focus groups consist of a moderated discussion with potential users. It is especially useful to make an initial analysis of the people's attitudes and beliefs. Within a discussion setting, the participants express their subjective feelings and ideas guided by a facilitator. The particular advantage of this method is that it brings up ideas that would be missed in a questionnaire or a one-on-one interview situation. Relevant information is also revealed through the interaction between the participants.
Structured interview	The interview is a method for discovering facts and opinions held by potential users of the system being designed. It is usually performed by one interviewer speaking to one informant at a time. Reports of interviews have to be carefully analysed and targeted to ensure that they reveal relevant information. An interview can typically gather more information than a questionnaire and go into a deeper level of detail. Interviews are good for getting subjective

Method	Description
	reactions, opinions, and insights into how people reason about issues. Based on the information required, an 'interview schedule' is prepared. This is a set of topics that one needs to discuss with the interviewee in order to obtain that information. One decides on the order in which to cover the topics. For each topic, an 'askable prompt', an instruction on how to ask for the respective information, should be prepared, as well as an explanation of each topic (in case the informant does not understand the 'askable prompt'). For a highly structured interview, each topic will be broken down into a series of sub-topics, each with their own 'askable prompt'.
Field observation	Field exploring describes a technique where the potential user is observed in his work environment. The technique can be used to gather information about tasks and processes that need to be considered for RESOLUTE application development
Operation Experience Review (OPEX)	With the OPEX technique, best practice and worst practice experiences can be identified. Therefore potential users have to report critical incidents (incidents that need a contribution of the user) during task processing.
Persona	Personas are a detailed description of a potential user group, their characteristics and user behaviour. Therefore fictional users and their requirements (gathered from interviews or observation) are described.

Table 4: Prototyping methods

Method	Description
Sketches	Sketches are used to represent “first ideas”, whether about the contents that will be displayed in a user interface, about specific functionalities of the system or about the metaphors that will be used in the system. Sketches are used in the first stages of the design process, even before working on the requirement analysis. The main advantage of sketching is the velocity of production, which permits designers to make a number of changes from the initial concept, as well as providing a way to encourage discussion and debate.
Paper mock-up	Paper mock-ups are made with elements like paper, pencils, post-its and scissors. Paper mock-ups provide a cheap and versatile way to simulate scenarios of use. The objective of a paper mock-up is to check if users are able to perform specific tasks, by simulating different states of the interface as the user performs actions. Different states of the user interfaces are drawn in separate sheets of paper, which allows designers to simulate the transitions between states that would happen when the user interacts with the system.
Click demo	A click demo is a low fidelity digital prototype that implements some interactive elements of the interface. The focus of the prototype is not on the look and feel of the interface, but in the actions that the user can perform in order to fulfil a task. Click demo prototypes will help designers refine the page flow before implementing any graphical aspects of the interface.
Functional prototypes	In the RESOLUTE pilot tests, functional prototypes will be tested and evaluated. They will be versions of the applications that show the desired functionality, at least under pre-defined limiting conditions. They allow for the most realistic testing and the identification of the broadest range of possible errors in design or technical functioning. They are useful at the end of a development process, based on the effort necessary to create or adapt them.

Table 5: Evaluation techniques

Method	Description

Method	Description
Cognitive Walkthrough	The Cognitive Walkthrough (CW) is a usability inspection method that aims to assess the ease of use of a design through exploratory techniques, based on a cognitive model of learning and use (Wharton, Rieman, Lewis, & Polson, 1994). To do so, a set of expert evaluators or a set of prospective users is asked to perform a series of tasks using a prototype of the interface. The evaluators will use information about the cognitive factor of a set of target users - experience and acquired knowledge – to check if the interface fits their mental models. Each action within each task should be thoroughly reviewed, aiming to elicit whether all target users will understand the actions and responses of the interface. The CW method has, for example, been enhanced for safety critical purposes (Bligard & Osvalder, 2013).
Wizard of Oz technique	The Wizard of Oz technique (Ardito, Buono, Costabile, Lanzilotti, & Piccinno, 2009; Nielsen, 1993) is a very helpful method to simulate system behaviour. In user testing, this technique has a user interacting with an interface without knowing that the responses are being generated by a human, not a computer. This allows testing of some difficult interface concepts before a system is fully working on a functional level.
Thinking-aloud technique	A thinking-aloud test involves having a test subject use the system while continuously thinking out loud (Lewis, 1981). By verbalizing her thoughts, the test user enables the developer to understand how he views the computer system. One gets a very direct understanding of what parts of the dialogue cause the most problems because the think-aloud method shows how users interpret each individual interface item (Nielsen, 1993). Disadvantages of this method have been widely discussed (Hertzum & Holmegaard, 2015). A problem of the thinking-aloud method is that it can't be used together with time measurements, because the need to verbalize can slow users down. When using the think-aloud method, the experimenter should often prompt the user to think out loud by asking questions like "What are you thinking now?" and "What do you think this message means?"
Usability Questionnaires	Standardised questionnaires can be used to measure statistically the user experience and user acceptance of a system. Recommended questionnaires are the AttrakDiff (Hassenzahl, 2003), and the Isometrics-S (Willumeit, Gediga & Hamborg, 1996). For other, newer instruments, such as the USE questionnaire (Lund, 2001), validity is likely to assume yet not proven.

The chapters below describe which of the above mentioned methods are planned to be used with respect to which of the RESOLUTE applications.

2 CRAMSS

The Collaborative Resilience Assessment and Management Support System (CRAMSS) for Urban Transport Systems (UTS) will be the core decision making unit and form the most sophisticated part of the front-end platform of the RESOLUTE system. In particular, CRAMSS will be implemented in such a way, so as to realize all functions and to conform to the guidelines drawn in WP3. Receiving input from the back-end processing units, it will come up with the final decision regarding the optimal resilience-oriented actions. Last but not least, the CRAMSS will be the interface between the theoretical part of the UTS resilience system and the real world use cases, using state-of-the-art technologies. Its output will be communicated through the CRAMSS operator's control centre (i.e. central GUI) and the mobile apps of tasks T5.3 and T5.4 (personalized GUIs).

The main purpose of the CRAMSS is to support reference actors at the UTS, such as infrastructure managers, with their decision making under both, standard operating conditions and emergency conditions. The CRAMSS will display information from different sources or independently running web-applications, together with the results of the decision support. It may come in handy not to directly merge all sources of information into a single application window: when new sources become available, the integration with the CRAMSS may be less cumbersome, which will contribute to the longevity of this tool. Apart from reducing costs for the technical adaptation, this may also reduce the users' efforts required to learn how to use the system after substantial updates.

An important part of the CRAMSS's decision support functionality lies in resilience assessment and resilience management (compare GA, p. 136). Based on risk analysis data introduced into the Back-End, such as risk maps, the CRAMSS calculates event-specific resilience indicators as an operationalization of how resilient the respective UTS is. Such measures support the management of the UTS's resilience by providing direct feedback on the consequences of any reassignment of resources. Thus, the CRAMSS is meant to help its user to assign resources where they are most effective, given actual or hypothetical/predicted circumstances.

The CRAMSS is planned to operate in an alert mode when an emergency or a high risk situation was detected and in normal mode when there are no greater disruptions present or expected. In alert mode, the CRAMSS provides its operator with different representations of real-time information that may be helpful for dealing with the situation. For example, the positions of travellers or vehicles may have an effect on how to re-route people, thus avoiding crowding up of such persons or vehicles and subsequent mass-panic, speeding up rescue and maintaining urban mobility to a greater extent.

From the perspective of user interaction design, it is important to note that the CRAMSS will not substitute existing systems at the operator's or manager's control desk. It will be an additional system, even though it may share common features with existing ones, or serve to reach the same goals (such as communicating with rescue professionals). This is important because, as a consequence, the CRAMSS will not represent the standard emergency procedures in the control rooms of the RESOLUTE pilot sites – which would in any case be unrealistic due to the differences between the application areas, legal background, etc. It will instead have to fit in between the existing processes, providing shortcuts or boosting efficiency by addressing relevant needs and bottlenecks that are expected to arise in emergency conditions.

2.1 Target users

Target users of the CRAMSS are managers and decision makers at Critical Infrastructures (CI), as well as so-called "operators". A relevant characteristic of a user of the CRAMSS is thus that such an operator is a person entitled or empowered by the organization to take decisions during normal operations and in cases of emergency.

In this deliverable, the term operators refers to all persons working at a CI who are in charge of monitoring the flow of vehicles or passengers and whose responsibility it is, in a case of emergency, to redirect traffic or person flow or to coordinate mitigation attempts. These professionals are trained to know the procedures to be followed in different types of emergency, usually based on a handbook with clear instructions. They are trained at using the tools available at their workplace, including IT-infrastructure for monitoring or steering the flow of traffic.

Managers or other decision makers are persons with a higher responsibility and executive power, yet they are not necessarily involved directly in ground level operations. They are not necessarily aware of the detailed procedures to be followed in emergency situations. Their primary task is to provide the correct resources and to make strategic rather than tactical decisions, thus ensuring that the CI is constantly maintained at a partially or fully functional level.

Target users of CRAMSS for the Florence pilot will be the City Administration, led by his excellence the Mayor of Florence, with the following divisions:

- the Mobility division, supervising and regulating traffic and main public and private transport infrastructures
- the City Police, patrolling traffic, the first to escalate problems in daily operations and to take care of ordinary stresses
- the Civil Protection – a critical function, which is triggered in case of natural disasters – it can be triggered on event-driven basis, or upon political decisions, and
- the Information Technology division, which provides internet, intranet, data, business continuity, IT disaster recovery, etc.

Under the supervision of the City Administration other operators from all the main public and private utilities may possibly become involved in the use of the CRAMSS, such as:

- Bus company
- Tram company (and their subcontractors)
- Street maintenance company
- Street lights and signage company
- Taxi companies
- Rental companies
- 2 national high speed railways companies
- Regional railway organization

Other actors that might become involved in ordinary stress or extraordinary events in Florence are:

- Fire Service
- State Police
- State Military Police (Carabinieri)
- State Financial Police
- Region of Tuscany Civil Protection
- National Civil Protection
- Regional Hospitals

Out of these many possible actors or involved organizations, represented by different persons, the development will be focused on the users with the broadest range of responsibility and influence regarding decision making. These are the users that need to access the greatest range of different sources of information and make the most complex decisions – affecting several subsystems or organizations. These users are the representatives of the four divisions led by the Mayor of Florence.

Target users of CRAMSS for the Athens pilot will be Critical Infrastructure Managers, mainly Metro Operation Control Centre (OCC) Managers, as well as Managers of First responders. A list of CI Managers and first responder managers of the agencies involved follows.

Critical Infrastructure Managers

- OCC Manager
- Traffic Regulators
- Power Regulators
- Information Officers

First responders

- Fire Service managers, as well as managers of the supporting agencies involved
- General Secretariat for Civil Protection (CP) and its Operational Centre 199 SEKYPS
- Region of Attica CP
- Police Officers (GADA)
- EMAK Rescue Team
- EKAB first aid and
- Hospital managers

2.2 Scope and objectives

The scope describes the main cornerstones of the application according to what has been defined in the Description of Work (DoW). The objectives describe the behaviour of the application from the perspective of the user: what needs to be achieved (compare ISO 9241). These objectives later form the basis of usability engineering and usability testing.

The CRAMSS is being designed based on the identification of three key challenges related to achieving resilience in UTS:

"*1) excellent coordination between different relief /rescue groups;*

2) appropriate information (especially geo-referenced information); and

3) intelligence in communicating orders and information to different participants" (GA, p. 148).

From a user's perspective, the CRAMSS is a tool used for achieving the following objectives. Under normal working conditions (normal mode), the main objectives are mostly related to the resilience cornerstones ANTICIPATE, MONITOR, and LEARN:

1. Increase the resilience of the UTS;
    a. Assess the current resilience-status of the UTS through an index figure provided by the CRAMSS.
    b. Apply the ERMG at the UTS organisation, with the help of the CRAMSS. ("*The CRAMSS System to be developed within RESOLUTE is meant to operationalize the ERMG guidelines for UTS*"; GA, p.148).
    c. Prepare the UTS for anticipated disruptive events; spend resources efficiently under given non-alert conditions

   d. "Coping with uncertainty" (GA, p. 135): create resilience strategies, by manipulating "control points", "conditions" and "actions" (see D4.1 and Annex) to account for complexity in disruptive situations.
2. Detect disruptions when they occur. → Start appropriate countermeasures (e.g. resilience strategies)
3. Predict disruptions before they occur. → Start appropriate countermeasures (e.g. resilience strategies)
4. Monitor the flow of traffic / users: check details on collected information from sensors and other data sources (such as risk maps); check results of calculations done in the back-end. Make sure the circumstances are right for the selected countermeasures.
5. Manually start the alarm mode, if necessary, to access automated resilience strategies.
6. Upload new training contents to the GBTA
7. Train with the CRAMSS training features – learn meta-competences and get faster in using the CRAMSS.

Under alarm mode, the main objectives are mostly related to the resilience cornerstones MONITOR and RESPOND:

1. Quickly get a reliable overview of the disruptive situation / event.
2. Efficiently decide on a resilience strategy to absorb a disruptive event and start the strategy if necessary. This may include
   a. Evacuating vehicles or traffic infrastructure, such as metro stations
   b. Redirecting passenger flow (persons or private vehicles)
   c. Redirecting transport vehicles of the UTS organization (e.g. buses)
3. Efficiently recover from a disruptive event.
   a. Detect malfunctions, dangerous areas, etc.
   b. Assign resources for recovery
4. Terminate alarm mode once acute danger has been dealt with.
5. Assign roles to rescuers, possibly through individualised messages.

2.3 Features

The features of the CRAMSS provide support for the four cornerstones of resilience. While some features may address several cornerstones, others are limited to only one of them. The features are described in detail below. This is how the CRAMSS shall support resilience:

- ANTICIPATE: The most relevant function for planning ahead is the ex-ante definition of resilience strategies, which can be altered by the operator, including the definition of onset conditions for each strategy. As far as available, the calculation of the resilience assessment, based on the input received, can in some cases result in predictions about future needs and consequently helps the user to plan ahead and reassign resources accordingly. However, the availability of predictions depends on the type of event (e.g., currently, there are no prediction schemes for the water bomb scenario in Florence).
- MONITOR: The monitoring features are relevant to support the cornerstones ANTICIPATE and RESPOND. In normal mode, it allows the user to develop a better understanding about relevant interrelationships between certain subsystems, which is useful for anticipation of events and optimal assignment of resources. In alarm mode, monitoring helps to quickly adapt to unpredicted changes, increasing the efficiency of the response.
- RESPOND: In the emergency condition, the CRAMSS provides a quick overview on existing resources and needs through the monitoring functions, thus reducing the time required for mapping these to one another and organizing rescue and mitigation. Decision support on the best resilience strategy further speeds up the process. Sending messages to users also increases the efficiency at absorbing the disruptive impact. Also during the aftermath, be it in the short-term, medium-term or even long term, the

monitoring functions allow the user to adapt processes continuously for a better result. If certain transportation paths or vehicles have been destroyed in a disruptive event, the CRAMSS helps monitoring the substitute traffic.

- LEARN: Resilience is based on learning rather from successful operation than from disruptions (see D2.1). Recordings of past events can contribute to understanding how to improve reactions to similar events in the future, with respect to successful and unsuccessful operation.

In order to help the user achieve her objectives, the following technical features are foreseen.

- <u>(Invisible) background features, relevant for other visible features:</u>

  1. **Retrieve data** from the back-end (traffic data, weather data, etc.)
  2. **Import user profiles** from ESSMA

- <u>General features always available to the user:</u>

  1. **Resilience assessment**; calculate and display current resilience assessment indicator(s) ("estimate the risk level of the ongoing situation"; GA, p.151).The resilience assessment is expected to quantify the feasibility of different options available to the operator, e.g. for deviating traffic to different routes.
  2. **Display available data** in the pre-defined format (e.g. bus positions on a map; weather, vehicles, safe vs. unsafe spots, etc.).
  3. **Display expected risks** (if any) based on predictions (weather forecast, upcoming local events such as concerts, etc.). If available, this will include a prediction of critical events, based on data and algorithms (currently, neither water bomb nor terrorist attack can be predicted with the available data).

- <u>Features available to the user in normal mode:</u>

  1. **Provide advice** based on the ERMG, e.g. on detected bottlenecks. This may also include process information for specific event types (e.g. what to do sequentially in a water bomb scenario). The most important example of this function is to inform every connected operator, based on real-time data and predictions, what is happening in which – general – steps based on the guidelines may be necessary to take (further down named "prediction based priority alignment function"). The idea is not to do the decision on priorities for the operator, rather to empower disperse operators to align their actions.
  2. **Upload training contents** for the GBTA.
  3. **Execute training exercises** for the operator and analyse the training data; display the result of the training.
  4. **Start the alarm mode** based on real-time sensor information or on manual user command.
  5. Administrative functions: **Assign roles** to users of the ESSMA.
  6. Administrative functions: **Create / edit / delete resilience strategies** and respective onset conditions.

- <u>Features in alert mode:</u>
  1. **Aid the evacuation** of certain areas or CI by decision support, i.e. through identifying the optimal resilience strategy based on the profiles of the persons involved (GA, p.151)
     a. Detect people to be rescued. Assign task: self-rescue
     b. Detect possible rescuers. Assign task: rescue. Other task types to be assigned ("first aid support")?
     c. "Routing": Display movement requests to civilians via

i. Situated displays
ii. Traffic lights
iii. users' handheld devices → see ESSMA

d. "Routing": guide rescuers to the position of the people to be rescued.
e. Apply an individualised resilience strategy, based on the specific situational requirements: fine-tune the resilience action taken (e.g. close an additional node not foreseen in the pre-defined resilience strategy triggered).

2. Communicate in a personalized manner to the citizens / emergency actors. "*Providing context aware, personalized and timely communication through multiple channels to drive the people opportunistic behaviours in different risk scenarios*" (GA, p.131, Obj3).
3. Stop the alarm mode based on a user command and go back to normal procedures.

Based on the currently available collection of data sources (see Annex I), the information content and the related display modalities of the CRAMSS can be summed up as follows:

- Map data: static Patterns, such as risk-areas in colour-coding.
- Map data: dynamic Patterns, such as traffic jam visualization or river height data and flow predictions). "*Monitoring the event evolution dynamics (extension, impact, etc.) and the behaviours/movement of the emergency operators on the field*" (GA, p. 131, Obj3).
  - o In the Florence pilot: proposed re-routing of individual traffic in cases of flooding. To be visualised are pathways and proposed configuration of specific traffic signalling.
  - o In the Athens pilot: substitute modes for cases of terrorist attacks. To be visualised are pathways, possibly with vehicle frequency, active and inactive stops/stations.
- Map data: points of Interest, with context information (e.g., location of a school, displaying if the school is open or closed, how many persons are expected to be there, etc.)
- Output not involving maps: automatically aggregated information from social networks (twitter) or public sources (CrisisNet, GDELT, etc.). To be visualised as clustered text, clustered lists, etc.
- Possibly (partly) map-based: location of trustworthy citizens to possibly be engaged as ad-hoc volunteers; detailed context-information on these citizens ("*Management of citizen identity, collective behaviour and reputation based profiling, taking into account dynamic aspects of user behaviour, profile, cognition, capacity, reputation, and role in the off-line social network, etc. in order to dynamically engage people as ad-hoc volunteers on the base of the event occurring*"; GA, .131, Obj3). This may require mapping critical events and categories of helpful skills, so the operator of the CRAMSS may rapidly identify what skills she can choose from and where the nearest person with that skill is located.
- Possibly (partly) map-based: "*analysing cascading behaviour in UTS modelled network, predicting in time the evolution of the network itself and its resilience metric with respect to the degradation of service (effect) and not only node failure (both cause and effect)*" (GA, p.148). It is required to display outcome variables in dependency of the factor "time".

To support the internal discussion and a fast start into the development, based on the objectives and features, use cases were created. They are found in the annex of this document.

2.4 User requirements

2.4.1 Based on the Description of Work

Relevant design criteria / user requirements are:

1. Provide "context aware, personalized and timely communication". (obj.3)
2. Only display the most relevant information (obj.3)
3. Reduce time distance between early warning and required action (obj.3)

4. The CRAMSS will be designed in a way that supports the integration of new sources of data through "*an open, service oriented, multi-layer architecture*" (GA, p. 148). Thus, the user interface needs to be designed in a way that requires minimum training (or none at all) for the operator when data sources are changed.
5. User state/trait variables and situational variables to take into account: *"extreme stress", "uncertainty, compressed timelines", "lack of information and information quality", "multiple actors", "requiring dynamic, real-time, effective and cost-efficient solutions"* (GA, p. 150).

2.4.2 Based on the RESOLUTE workshop results

D7.2 reports the outcomes of the RESOLUTE workshop held in Florence, Italy, on December 15th 2015. The workshop identified user requirements to be taken into account in the creation of the WP5 applications. The requirements related to the CRAMSS are summarized here, together with a conclusion for the design.

1. Flooding scenario: The main difficulty lies in localising the boundaries of the phenomenon and the prediction of possible consequences; both aspects are highly variant and difficult to predict. This is to be achieved through the monitoring functions (D7.2, pp.11-12). Thus, the monitoring function needs to provide risk maps and real-time data to assess the current status in parallel. In the best case, both can be visualized on the same map while making intuitively comprehensible which data are static scenario data and which are real-time data. In the respective subcases, the following processes may, in case adequate data is available, be supported by the CRAMSS (D7.2, pp.16-17); the implementation depends on WP4 developments. The User Interface design needs to ensure that the CRAMSS supports the user in easily completing these processes in the correct order, or even in another order if necessary.
    a. Underpass blocked by water: "informing that the underpass cannot be used" and "traffic re-routing and adaptation."
    b. Social valuable places: "evacuate the place", "prevent further accesses to the place" and "recognition" (identify such a place based on the dataset).
    c. Flooded roads […]: "change traffic light cycle", "urgency ranking".
    d. 30 years / 200 years flooding: "evacuation plan definition", "citizen information", event monitoring, close access to the affected areas, mobilise resources to rescue people and goods, activate countermeasures, suspend / partially recover public transport service (only 200 years flooding), "activate short-term recovery plan", and "detect recovering areas".
2. Vehicle accident scenario: The challenge in this scenario lies in quickly and efficiently redirecting traffic (D7.2, p.13). To serve this purpose, the CRAMSS monitoring and DSS needs to identify the location of the accident and propose a solution for the redirection of the traffic that can be started quickly, to avoid traffic congestions. Thus, the CRAMSS's map needs to provide a sufficient resolution to identify the relevant size of the blocked street or road and to take into account which other streets or roads are available for re-routing the traffic. The following processes are supposedly relevant:
    a. Cars / train: monitoring traffic levels, send information to the other road users, establish possible alternative paths, separate or block affected areas, advise emergency units.
    b. Dangerous goods: advise special responsibles
    c. Motorcycles: advise emergency units
3. Bomb attack scenario: A bomb attack on a metro station will possibly result in the need to close several stations along the affected line, or even a complete shutdown of one or several lines (D7.2, p.14). This immediately creates considerable complexity in the re-direction of user flow and traffic. The following processes may be particularly relevant:
    a. General case: Immediate information (from OCC) to the first responders, social media monitoring.
4. Large yard event: no general requirements, additional to the ones already defined, seem to arise from this scenario. The following processes should be considered:

   a. Detect the event in real time, guide the people to the nearest exit, advise emergency units.

➔ To support the correct following of the processes, a guidance feature on the sequence of processes should be provided by the CRAMSS, directly linked to the CRAMSS features supporting these processes (e.g. a hyperlink to open the required monitoring function).

Additionally to the defined processes and requirements of each scenario, the workshop led to several relevant conclusions.

1. In the resilience processes, a multitude of actors from different authorities is involved, and responsibilities and processes may not always be well-defined.
   → To account for this, the CRAMSS should list the correct or possibly relevant affiliations or persons to be contacted.
2. The need to "optimally manage the scarcity of resources in term of first responders, goods, and tools available during an emergency" (D7.2, p. 27) is accounted for by the features of the CRAMSS, not the UI.

2.4.3 Based on standards and the ERMG

The ERMG name key standards to be heeded in UI design of the CRAMSS:

1. EN 614 Parts 1 and 2 (Machine safety requirements).
   a. Work task design (EN 614-2) is relevant as through the design of the features and interaction concepts of the CRAMSS, operator work tasks are being defined. Although the CRAMSS will fit into a mostly already defined job, the "new" operator job including the use of the CRAMSS should meet the criteria defined in the norm. Important in this context are, in this order, "over- and underload", "feedback", "autonomy", "learning opportunities", and the "meaningful whole".
      i. "Over- and underload": Mental overload is avoided by providing step-by-step guidance through the process and limiting the functionality of the CRAMSS in alarm mode. Underload is also to be avoided as it can lead to stress. This is supported by offering widespread functionalities in normal mode, including monitoring data and features for defining resilience guidelines
      ii. "Feedback": feedback is essential to provide the user with information on his/her own effectiveness and a requirement for long-term motivation. It is particularly necessary in the emergency case, as fast behavioural adaptations may become necessary. The CRAMSS's monitoring functions and the resilience index fulfil this purpose. The resulting design requirement is that these need to be always available and that whenever possible, the DSS should propose the correct monitoring function based on system priorities (e.g., location of possibly helpless people, people flow in the area, etc.).
      iii. "Autonomy": the GUI is split into widgets which can be arranged by the user based on the current needs. This also reduces mental workload.
      iv. "Learning opportunities":
2. Control room standards such as EN 11064 – Part 5 mentions quality criteria for control centre technology, most of which are applicable – at least to some extent – to the CRAMSS Two of these criteria are of particular relevance:
   a. System authority: The human operator always needs to be in (final) control of what is going on.
   b. Memory: The design needs to take the human short-term memory span into account. All system processes will be designed in a way that avoids, wherever possible, the use of short-term memory and ensures that such processes, if they cannot be avoided, cannot lead to critical errors.

3. EEMUA 191 equals EN 62641-9 and particularly defines alarms and conditions from a perspective of (electronic) system engineering. It defines different alarm states, which are relevant for the design of alarms given by the CRAMSS. The CRAMSS alarms should thus allow for the following actions or assignment of attributes:
    a. *Confirm*: the user informs the server that corrective actions concerning the cause of the alarm are being taken.
    b. *Disable*: the system will not generate certain alarms.
    c. *Refresh*: an update on an event subscription is provided.
    d. *Shelve*: the user temporarily prevents the alarm from being displayed.
    e. *Suppress*: Logical rules prevent the alarm from being displayed, even though the onset conditions are fulfilled.
4. ISO 6385:2004 (Ergonomic principles in the design of work systems) may be a helpful norm to assess the overall working situation around the CRAMSS, as a second priority after making sure that all requirements of EN 110764 have been respected.
5. “Staff should be involved in the design process” (D3.5, p. 109). This has been realised by basing the development in information collected in workshops and end user interviews, and will further be ensured by doing focus groups and user testing with the respective end users.
6. “Monitoring interfaces should be usable in both normal and emergency situation. The CHI design and evaluation needs to be conflict free, independent and stakeholder and situation oriented” (D3.5, p. 109).
7. “Human Factors concerns on human-computer interfaces, contents and dialogues should be set up in order to ensure easy, safe, comfortable and efficient interactions avoiding errors or any type of fatigue or distraction” (D3.5, p.133).

Another relevant standard is EN ISO 9241-110; it describes ergonomic principles for the design of dialogue systems. The CRAMSS is a dialogue system, thus the norm is applicable.

a. Suitability for the task: Making only the most relevant aspects visible to the user is difficult, as the tool is made for uncertain and dynamic situations and thus restricting the user is not a good idea. However the design needs to hide background processes (such as data retrieval), provide output in the required format (e.g. an export of the events log as a digital spreadsheet format), macros for recurring subtasks (resilience strategies), storing old data values (e.g. storing the user preferences of maps – which POIs to show, etc.).
b. Self-descriptiveness: This is achieved through user testing and making sure the terminology used allows for fast recognition of elements and features. Tooltips are added for this purpose, as well as a system status monitor. If possible, a list of actions is presented in emergency situations to minimise the need for instructions. A styleguide will be provided for the monitoring functions for this purpose.
c. Controllability: As already mentioned, the CRAMSS is defined in a way that allows the operator to interrupt and resume the CRAMSS tasks at any point in time. Providing the UI in the user’s language is also commonly referred to as a controllability feature (e.g., Ertl, 2010).
d. Conformity with user expectations. This is achieved through user testing and by adopting as many commonly known UI conventions as possible. The map, e.g. features controls known from common maps, such as “maps.google.com”. Logout and configuration features are found in the upper right corner, as in most web-based applications (Google, Facebook, Amazon, etc.)
e. Error tolerance: All user actions should – based on what is practically possible – be reversible. In cases where this is not directly possible (e.g., once a resilience strategy has been started), decisions will be require a second / separate confirmation.
f. Suitability for individualization: This is attained by following the widget approach, allowing the user to create her own user interface.

g. Suitability for learning: The current design allows the user to first master the main features, such as monitoring and starting resilience strategies, while administrative features, such as the creation of resilience strategies can be used and learned at a later stage without limiting the action capability of the operator in emergency situations.

The requirements related to psychological strain in ISO 10075-1, Nielsen's heuristics for designing dialogue systems (Nielsen, 1993) are similarly relevant.

Furthermore, implications for the design of the CRAMSS were deducted from NUREG 0700 (Human System Interface Design Review Guideline from the U.S. Nuclear Regulatory Commission, 2002) and Bockelmann, Nachreiner & Nickel (in press); these are reported in Table 6: Exemplary selected guidelines for control rooms and CRAMSS implications

Table 6: Exemplary selected guidelines for control rooms and CRAMSS implications

Guideline(s)	Implications for the CRAMSS
Consistent interface design conventions should be evident for all display features (such as labels).	design and interaction of widgets should be consistent over all widgets
Information should be displayed consistently according to standards and conventions familiar to users.	The layout and design of the web based CRAMMS should be in alignment with standards for web page design (e.g. login/logout functionality in the upper part of the page; scrolling should be avoided)
There should be an explicit mapping between the characteristics and functions of the system to be represented and the features of the display representation.	Changes in the appearance of the CRAMMS widgets should have a one-to-one relation with the CI states it represents.
The characteristics and features of the display used to represent the process should be readily perceived and interpreted by the operator.	Icons and graphics of the CRAMMS should be designed in a way, that the operator understands it meaning on first glance
While viewing secondary (lower-level) displays, a perceptual (audible or visual) cue should be provided by the system to alert the user to return to the primary (higher-level) display if significant information in that display requires user attention.	In case of a status change on a basic widget/ window the user should be informed, independent of the widgets actually displayed
Information display systems should allow users to immediately assess overall plant status and detect conditions that require attention without performing interface management tasks.	The overall status of the CI should be displayed e.g. using an indicator), regardless where the user is in the system
Displays should contain reference(s) to the values of normal operating condition(s).	The CRAMMS should provide clear indicators for normal working conditions of CI and deviations from normal mode
Navigational links to and from high-level and lower-levels of information and to reference and supporting information should be provided when needed for operators' tasks.	The CRAMMS should support easy switching between widgets, e.g. by using back/forward navigation or breadcrumb navigation
Text displays should be worded simply and clearly.	When the CRAMMS user needs to enter text it should be clear what kind of information is requested and what format the entry should have.
The computer should acknowledge every entry immediately.	The CRAMMS should avoid a delay in system reactions.
When processing in response to an entry is lengthy, the user should be given some positive indication of subsequent completion.	When a user entry is processed, the CRAMMS system should provide a progress indicator.
The allocation of system components and its visual translation in the user interface needs to be clear and unambiguous	The CRAMMS should use colour coding to differentiate between system components and system conditions. A too obtrusive use of colours should be avoided - status

Guideline(s)	Implications for the CRAMSS
	changes might not be perceivable. Coding of information should be multimodal. The usage of colour only might exclude user with colour blindness.
The operator should be supported in carrying out daily work routine by appropriate support and learning systems.	Help functions should be context sensitive, understandable and easy to access. A help function in the CRAMMS could be a widget that supports the user in the prioritization of task within a defined resilience strategy.

2.4.4 Based on the target user description

With respect to the target users, their objectives and the area of work, the following requirements based on Human Factors research are particularly important:

1. The CRAMSS must be available in the local language for their users at the pilot sites. An English version will be produced as English is the common project language.
   → Languages: ENGLISH, GREEK, ITALIAN

2. Efficiency. During the alert mode, the CRAMSS is meant to speed up relevant processes. Thus, from the ISO 2941 criteria, efficiency is deemed the most important criterion, user satisfaction the least important one. The following requirements result from an increased need in efficiency of use.
   a. Short duration of tasks (multitasking); Intelligent routines to speed up operations
   b. Cognitive workload: similarity of routines; minimum number of layouts
   c. Maximize feedback for detecting errors
   d. Minimize time for fixing / resolving errors
   → Ensure efficiency of use, particularly in alert mode.

3. Minimize the occurrence of errors. Even though this could be part of the efficiency-requirement, this is stated as a separate requirement due to its importance. Errors could have fatal consequences and may be difficult to undo, once the given commands have been acted upon by rescue teams or other responsible actors in the field. Stress is a psychological function that decreases the level of detail perceived. This means that in emergency situations, the displayed information should be limited to a minimum, unless the user requests information in more depth. Based on experimental studies, user interface design takes advantage of the fact that recognition is faster and exceeds less effort than recalling (Loftus, 1971; Norman Nielsen Group, 2014). As a consequence, the different functions of the user interface will be designed in a way that makes sure recognition is available as often as possible. For example, providing a list of all monitoring functions to choose from decreases the need for recalling.
   → Avoid user-based errors. Reduce cognitive workload (need of memory and processing).

4. Task Adequacy: (Active-passive behaviour; Push- vs. Pull- scenarios; Processes fit smoothly into other activities; processes (apart from being short) can be paused, resumed or repeated when the operator wants to). The information needs to be presented in a way that maximizes the user's working efficiency and that allows for temporally not paying attention to the CRAMSS, as operators are usually required to perform multiple tasks in parallel during disruptions.
   → Unobtrusive active behaviour (e.g. when warning) / Task analysis.

With respect to the target group, some other Human Factors requirements are also important yet of secondary importance:

5. Learning effort: The users are professionally trained on the systems. Although minimizing learning effort is generally desirable, designs that increase learning effort are preferable if at the same time they are capable of increasing efficiency or decreasing the probability of errors.
   → Disregard learning effort in favour of efficiency

6. Attention span and perception: Humans have a limited capacity of perception when it comes to searching for changes or patterns over a longer period of time. While the quality of human perception is high, compared to what is currently possible with machine-based solutions, humans cannot stay focused too long. This is particularly true for an operator in a situation of crisis. Thus, information needs to be displayed in a manner that avoids the need for persistent attention (Richter, 2000). The system needs to provide options for easily viewing pieces of information together which belong together and support the user by registering events he himself may miss.
   → Avoid tasks that require an attention span of more than a defined number of seconds (to be clarified with the users).

2.4.5 Based on the objectives

1. Most safety regulations require a human actor to have the last say in decisions that affect actions in regular and emergency modes at CI. This is why the CRAMSS is a decision support system, not a decision system. All real-world actions need to be triggered by the operator. Furthermore, the operator needs to be able to override system features that are possibly malfunctioning. E.g., the operator has to be able to manually trigger the alarm mode, in case the alarm is not correctly detected by the sensors.
   → Organize real-world action triggers to have them all available when possibly required (independently of sensor input). Especially, include a trigger for starting/stopping the alert mode.

2. Connect information that belongs together. Decision support based on sensor information should be linked to the sensor's output visualization in order to allow the user to "quickly get a reliable overview of the disruptive situation / event".
   → Connect decision support and sensor information (e.g. via hyperlinks).

3. Assigning roles to users of the ESSMA is supposedly mostly related to the location of these persons, taking into account blocked pathways, exits, and other resources. Thus, the ESSMA users need to be displayed on a map, together with information on the user role.
   → Visualize person roles on a map.

4. Although the CRAMSS should be able to send automated individualized information, to users (e.g. concerning the correct escape path based on the user's mobility profile), it may become necessary to send messages that cannot be automated. This again ensures that the operator is empowered to have the last say in the messages being sent to users while commanding the evacuation. This also requires finding a (visual) representation for the messages sent to the users, even though they are possibly (partly) individualized. Vectors on a map may for example indicate in which direction a person was sent through automated messaging.
   → Do not limit the operator to sending automated messages. Visualize results of automated messaging.

2.4.6 Based on the features

1. Although some features are only running in the background, it is important for the operator to know if everything is working well.

→ Include a feedback feature indicating the correct functioning of the CRAMSS background features.

2.4.7 Based on research and other relevant aspects

1. The SAVE ME project[1] (Grant Agreement No. 234027 of the European Commission) produced two key requirements of operators when interviewing operators of a road infrastructure (linked to police and fire brigades) (Leuteritz, 2011).
    a. In the case of traffic incidents and traffic accidents, the operators want to decide by themselves, whether to ask travelers to self-evacuate. Thus, this option has to be always visible. Operators will take about 2 minutes for this decision. (Hence, an automatic solution after 3,5 minutes can be considered)
    b. The situation in the shelters should be described by numbers, not by masses of dots.

    → Self-rescue should not be triggered fully automatically (also for legal reasons). Simplify information, e.g. by providing numbers instead of dots.

2. The SAVE ME project also researched the requirements of metro operators (Leuteritz, 2011). Most of the findings are already represented in the list of features, such as the need for information on the disruptive event, alerting, and identifying the location of persons to be rescued. Additionally, the user requirements suggest that messages given by the CRAMSS should be divided into groups, depending on their urgency. Important messages should be demanding more attention than less important messages.
   → Cluster system messages into Level 1, level 2, and level 3 priorities.

3. The operator interviews conducted in the SAVE ME project (Leuteritz, 2011) revealed that travellers frequently disrespect orders, such as requests for evacuation. In a given example, travellers even attacked members of the police who were blocking the access to a subway platform during a fire drill. As a consequence for engineering the portal, the system should provide an active help to the operator while following up on the behaviour of groups of travellers and identifying locations where orders are being ignored.
   → Follow up on traveller behaviour, possibly by marking groups of people that show unexpected behaviour.

4. Supporting the OODA-loop: Based on the OODA-loop (observation, orientation, decision, action), which is still used as a basic Human Factors concept in designing mission-critical interfaces, the CRAMSS should help the user go from step to step and thus take into account that in non-equilibrium situations, the OODA-loop may be closed faster than in equilibrium situations (Rahman et al., 2008). Based on Gestalt-psychological principles, processes and visualizations should support the loop and actively decrease the rate of error, e.g. by displaying relevant controls sequentially or next to each other, or by making less relevant controls temporarily disappear.
   →Provide sequential or special grouping of information elements and controls to support quick OODA-loops.

5. The CRAMSS is a mission-critical instrument and compared to, for example, the ESSMA, it has one special characteristic: when a critical event comes up, no action might be better than a wrong action.

[1] The SAVE ME project produced a system for supporting self-rescue of civilians from traffic infrastructure. Thus, it is to some extent a predecessor of the RESOLUTE project and its results part of the relevant state of the art.

Thus, the support for fast decisions should not be provided in a way that supports overly fast decisions. The CRAMSS should prompt key criteria for the decision making and support taking a well-informed decision and consecutive action, rather than running the user through standard procedures.
→ Present currently relevant key criteria to help the user decide about "action vs. no action".

2.5 Technical restrictions

At this stage of the development, technical restrictions are not yet very clear. They will be monitored and completed along the course of WPs 4 and 5.

The CRAMSS will be a PC-based application or set of applications. Some of the CRAMSS's features will probably be browser-based, such as real-time maps. With respect to UI development, browsers impose the following restrictions:

1. Less screen space available and more controls visible (omnipresent browser taskbar).
2. Representation of contents may depend on the browser type and version installed.
3. Widgets may overlap if screen space is limited. Thus, urgently relevant information needs to be displayed in a way that it will always catch the user's attention.

2.6 Work plan: user requirements analysis

The key questions to answer in this requirements analysis for the CRAMSS are:

1. Which working conditions of the operator have to be taken into account in the design of the CRAMSS (noise; lighting; etc.)?
2. Which organizational aspects have to be taken into account in the design of the CRAMSS (responsibility or authorization level of the operator, involvement of other deciders locally or at other places, role of team or organisation)?
3. Which working processes does the CRAMSS need to fit into?
4. Which legal regulations or cultural / local effects have an impact on the working process?
5. Are the objectives relevant and the features useful to the users? What could be done to increase this relevance or usefulness? Which features are more, which less relevant?

In order to find out how to include the features offered by the CRAMSS into the working routines of the operators, it is important to analyse their working situation and to take their experience into account. Due to the number of different operators, it was decided to use the focus groups approach, in order to complete the information collected in interviews and the RESOLUTE workshop. Of particular importance is the complexity that may appear due to working across organisational, geographical or other boundaries, as this can have effects on the requirements for cognitive ergonomics or psychosocial ergonomics; additionally, cultural factors need to be taken into account, in the design as they "may affect cognitive processes, such as perception and understanding of security policies and computer security-related communication" (Carayon, 2006). Consequently, the user testing of the CRAMSS interaction concepts need to take these outcome dimensions into account. Most importantly, it is required to check the terminology used in the CRAMSS for possible inconsistencies with the official terminology used among all involved organisations. The testing also needs to address the relationships and past experience with professional users and civilians in disruptive events (e.g., what is required to ensure that other actors will assess the advice or orders given as valid and trustworthy?).

Compared to other UCD methods, a scenarios-based method is feasible because the CRAMSS is a complex tool and clear use cases are not available yet. While the features and sources of information are roughly known, it is not yet clear what exactly will be presented to the users and how the interaction of the user with the CRAMSS can fit into the working routines of different types of operators. The advantage of the scenario-based approach lies in the fact that it produces intermediate outcomes (scenarios) that can be shared among all involved partners and that can also be used to fuel discussions with end-users. Shaping scenarios provides a level of clarity that is useful for all involved parties, from the end users evaluating the usefulness and usability of the CRAMSS, to the UI-developers and the developers of technical backend functions. This allows for more precise feedback on possible issues related to the scenarios themselves or the solutions proposed, on a technical, social, organizational or individual level. It furthermore allows ending up with descriptions of processes that can be compared to the ERMG (D3.5 and D3.7) and the main resilience approach taken in the project (D2.1). The disadvantage of scenarios is that they can never cover all possible situations or use cases. Based on the final scenarios, a general UI concept needs to be crafted. This has then to be evaluated using classical evaluation techniques.

Generally, it is not feasible to orient the development at hard facts based on human limits, like in the design of an airplane cockpit. In order for the CRAMSS to achieve its aim of aiding in making efficient decisions, it needs to present rich – or enriched – information to the user. Decisions on how to limit this information in order to account for stress-related reactions of the user will rather be made on the basis of prioritising information than on shaping unique solution paths.

In order to support decision making under stress, methods and empirical knowledge from High Velocity Human Factors (HVHF) will be taken into account. The key goal of using these methods is to ensure that the user will always get the optimal situation awareness. This requires the being able

- to perceive the currently most relevant information,
- to comprehend this information, and
- to see the connection of this information in the context, to infer from this mental model what is about to happen and what could be done.

Based on the current concept of the CRAMSS, with respect to the requirements of HVHF, one particularly critical aspect is the representation of the resilience strategies. They are supposedly complex, both in their onset conditions and in their schemes of actions or consequences (which roads to block, which alternative routes to suggest, etc.).

The CRAMSS is meant to include different sources of information, which may even change after the conclusion of the project. New sources of information or algorithms may be added to enhance the reliability and usefulness of the CRAMSS. Hence, it is necessary to create a short style-guide that can easily be applied by the developers of such new functionalities. The style-guide ensures the learnability of whatever is added. Creating the style-guide requires defining key elements across the different possible functionalities, or at least creating clusters of similar aspects.

2.7 Blueprint of user interaction & experience

One approach to the CRAMSS would be to develop one main interface for the central functions related to the DSS and to implement the rest of the features as widgets. This grants the (professional) operator the possibility to arrange the information according to her own needs. In this, case, the central application must ensure that all widgets are available (thus, findable and perceivable). The blueprint presented here follows this approach. However, depending on the outcomes of the continued user requirements research, this assumption may be dropped at a later stage.

2.7.1 Draft implementation proposals for specific features

a) Background features

1. Retrieve data
   With respect to the background features, the user needs to know if everything is running well. One or several symbols in the header bar should indicate if all main background services/features are running. This applies at least to the connection to the back-end, possibly also to other services/features. This requires a self-test functionality to be implemented.

b) General features always available to the user

1. Resilience assessment
   Modes of interaction could be the following: Option A) The operator defines a resilience strategy, either from a list of "resilience strategies" or by indicating, e.g., the closure of a certain node on the map; then, the resulting resilience score is calculated and displayed. Option B) The system displays the recommendation to switch to another resilience strategy and displays the suggested increase in the resilience score.
2. Display available data
   Different visualization options were named above in the "features" section.
3. Display expected risks
   If, as currently planned, the different information functions (maps) are realized as widgets, then it is important to ensure that the user is informed about risks independently of which widget is currently in the centre of attention. Additionally, the current activity of the operator should not be interrupted. Expected risks will be displayed in window or similar element that is always visible in a certain part of the screen.

c) Features available in normal mode

1. Provide advice
   This feature needs to be specified once WP4 has provided detailed information on the sources and data processing available.
2. Upload training contents
   This depends on the format the training is provided in. Supposedly, a common file uploader may do the work, provided together with a feature to select the conditions that make the training available to the users (e.g., "if training 1 was completed successfully").
3. Execute training exercises
   Starting and stopping the exercise may be enough, if the training is just a simulated emergency condition, displayed in a window that can be differentiated from the actual CRAMSS, so the user does not mistake the training for a real-world problem.
4. Start the alarm mode
   A switch may be enough. It is important to avoid the frequently known usability problem of confusing an actuator (button) with an indicator of state.
5. Assign roles
   These functions will seldom be used and can thus be hidden away in a menu tree. A possible realisation would consist in providing the operator with a given set of roles (e.g., fire brigade, police, civil protection) and to define a password for each role that is required by the respective user of the ESSMA when registering in order to receive information related to this role. Also, a list of registered persons would be available, at least based on the telephone number used.
6. Create / edit / delete resilience strategies
   The representation of the strategies may need to be decided in cooperation with WP4 and based on further user requirements analyses. Depending on their complexity, maps, diagrams, tables or other visualizations may be adequate. The strategies could be displayed with a table of onset conditions, to select the type of conditional relationship, the independent variable and its cut-off value.

d) Features in alert mode
   1. Aid the evacuation
      User requirements analysis has to determine which manipulations by the operator should be enabled by providing respective interactive elements. At least, a map is needed for displaying the location of the users, the possible evacuation routes, an option for the operator to alter the routes (either by picking one out of various pre-defined resilience strategies, or by manipulating single evacuation paths) and an interactive element such as a button for starting the evacuation procedure. To which extent manual individualized control of certain elements such as situated displays and traffic lights is necessary will be subject to further research. In the extreme case, each of these elements or group of elements would need to be selectable from a list or a map and editable through a context menu.
   2. Communicate in a personalized manner to the citizens / emergency actors. "*Providing context aware, personalized and timely communication through multiple channels to drive the people opportunistic behaviours in different risk scenarios*" (GA, p.131, Obj3)
      Messages are personalized automatically based on the user profile. If individualised messages were to be sent to the users by the operator himself, then an extra dialogue would be required to select the recipients, e.g. by defining the location, typing the message (limited characters) and sending.
   3. Stop the alarm mode and go back to normal procedures.
      This should always be a manual function, so there needs to be a button to end alarm mode. A security check should be done to make sure the alarm mode is not ended accidentally.

2.7.2 Draft structure

The CRAMSS will, by definition, feature two modes, a normal mode and an alarm mode. Providing these modes serves two purposes:

1. Alert the user when a disruptive event is detected or at least very likely to happen.
2. Provide the user with specific features that are most relevant in the current situation – hide other functions that are currently not necessary. This boosts efficiency of use, the defined key criterion.

The structure of the CRAMSS is currently planned to be realized in the form of widgets or even web-based applications opened in a browser. Consequently, the CRAMSS main interface has to combine the additionally necessary functions, possibly ordered into blocks. The structure may look as follows:

1. Header. Includes:
   a. Title (to distinguish between CRAMSS and CRAMSS-Training)
   b. Alert – status and on-off switch for the alert mode
   c. OS-based interaction elements (e.g., minimize, maximize, close)
   d. Logout button
   e. Configuration / Options button
      i. User credentials (e.g. password change)
      ii. Language setting
      iii. Assign roles to ESSMA users
      iv. Upload new training materials
   f. System status (including a hyperlink to a list of components or a possible error message depicting the type of error).
2. Events log
   a. Key events should be always visible; this list should contain
      i. Events that have already happened (Example: "Water bomb in area X")

        ii. Events that are likely to occur (Example: “Civilians trapped in metro station Y”)
    b. A detailed list of system events should be collapsed yet available on request.
        i. System messages on events (based on different urgency levels)
        ii. Operator actions (e.g. “start resilience plan Z”; “Close W-Street for individual traffic”)
3. Resilience assessment
    a. Resilience strategy/plan # 1 plus resilience score
    b. Resilience strategy/plan # 2 plus resilience score (for comparison)

    Resilience strategies/plans could either be selected from lists (e.g. drop-down menus) or be defined using specific operators, e.g. on a map. This would require an extra button to “calculate the resilience score” of this very solution (note: also aftermath plans, including users to return to normal use of the UTS may be found in this list).

4. List of sources
    a. List all available widgets, such as maps, tables, calculators, etc.
    b. Each item in the list is a hyperlink that opens the respective element or brings it to the top.
5. Variable content space
    a. Displays one or several sources, such as a map or a table.

<u>Indication of mode differences</u>

In both, the actual CRAMSS and the CRAMSS used for training, two modes exist: Alert mode and normal mode. Colour coding of frame / background colours or similar will be used to stress the difference between these modes, which are additionally indicated by a graphical element such as a switch (to account for users with reduced colour-vision). Moreover, the design should indicate the difference between Training-CRAMSS version and the actual CRAMSS.

In the above described design, the features to disable in alert mode are hidden in the configurations menu. Unless user testing reveals a contrary requirement, it may not even be necessary to disable them.

Currently, other distinctions between normal and alert mode seem not to be necessary.

2.7.3 Scribbles

Scribbles are early, low-fi representations of graphical user interfaces or interaction concepts. As they represent a starting point for development, they will most likely change regarding several of their characteristics. Thus, it is not reasonable to produce hi-fi drawings at this early stage.

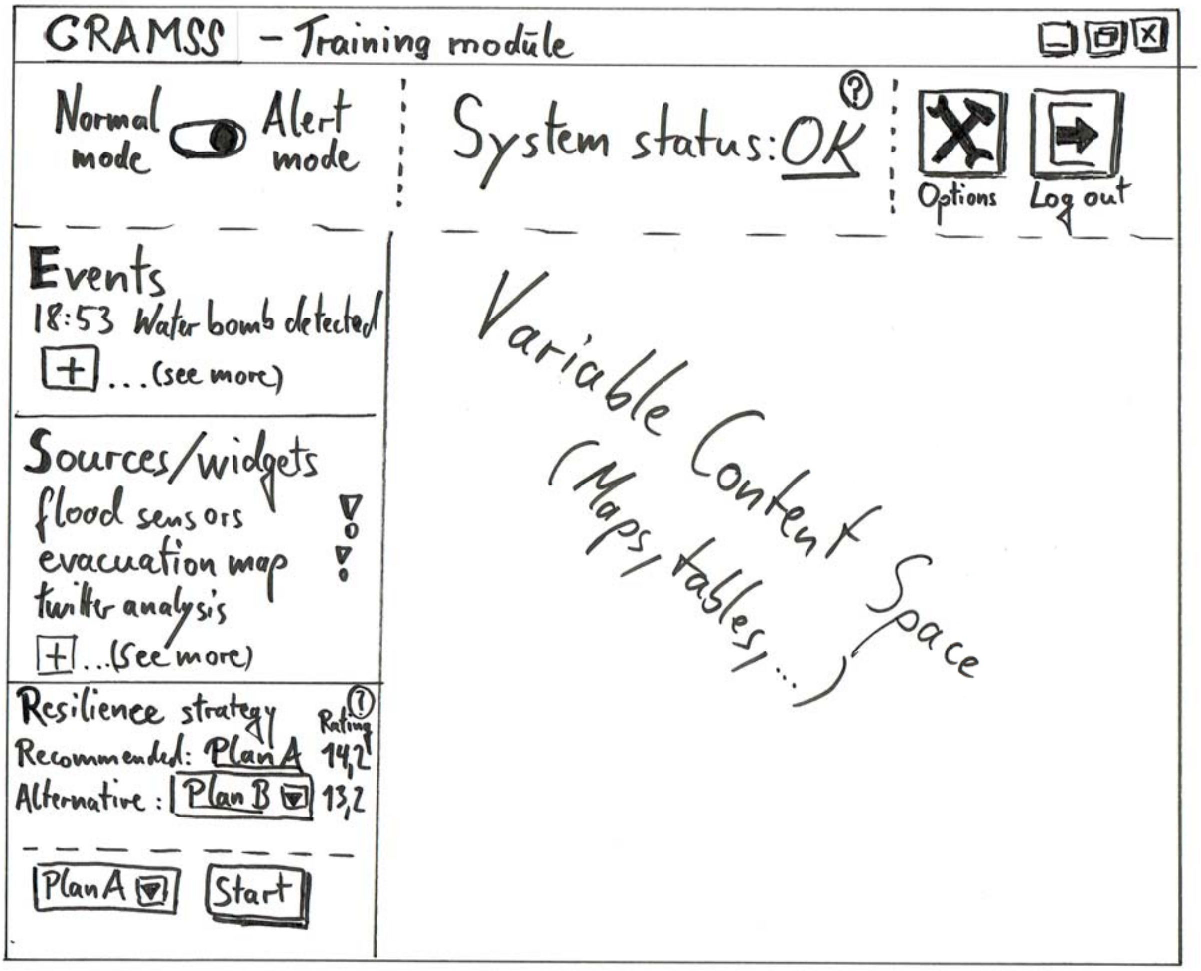

Figure 3: CRAMSS – first draft of the main functions

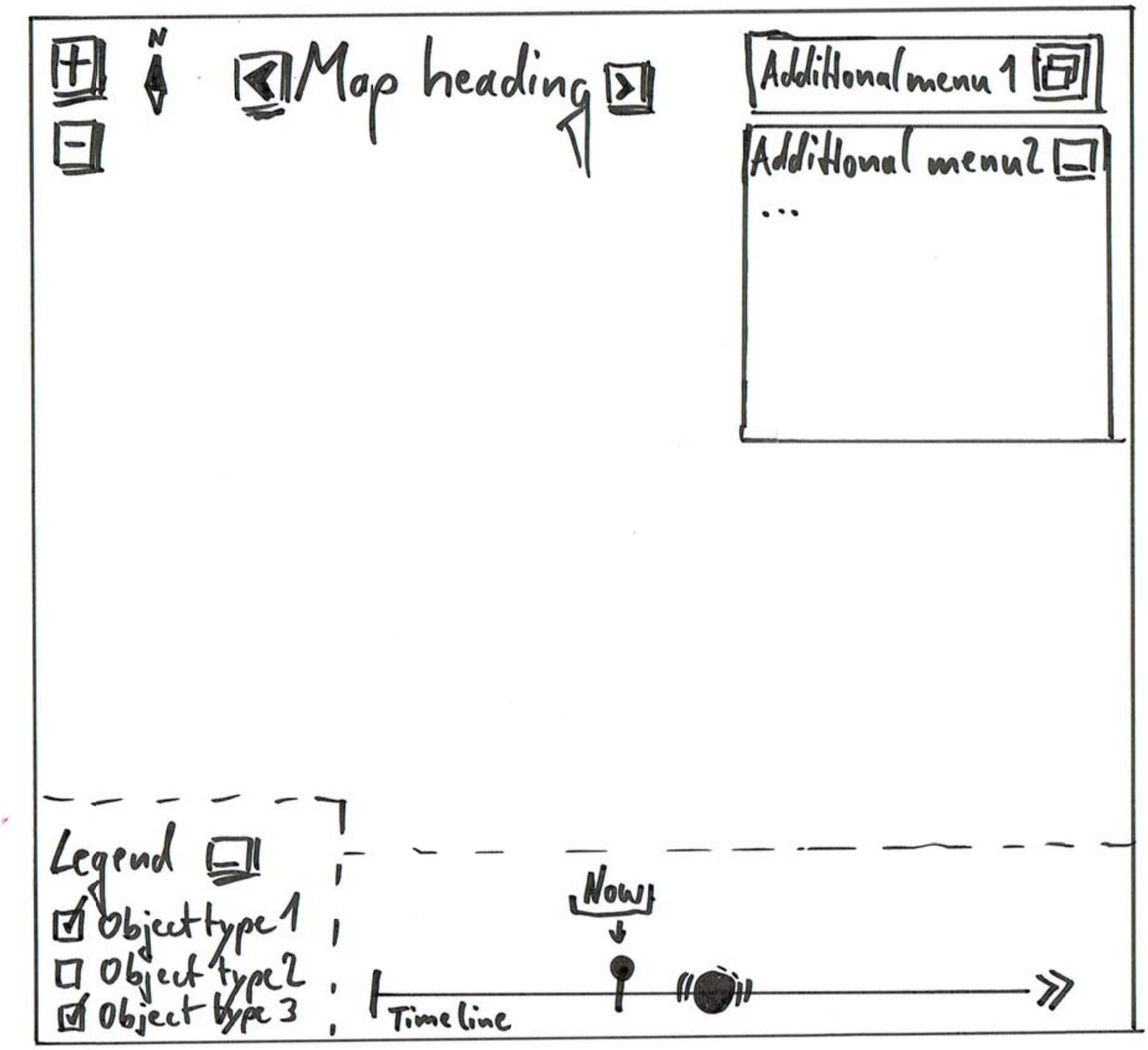

Figure 4: CRAMSS – first draft of the elements of monitoring features

2.7.4 Primary mock-ups

Based on the scribbles, primary mock-ups of the main CRAMSS interface were created. These mock-ups will be continuously improved through partner and user involvement.

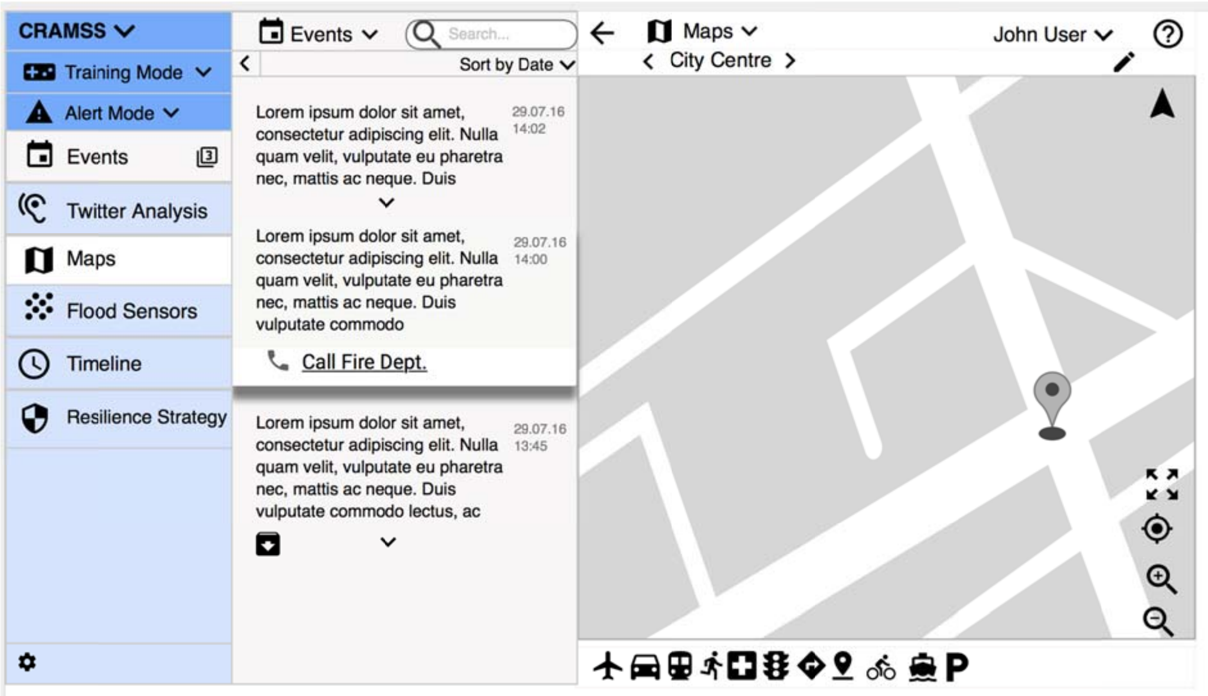

Figure 5 – Primary mock-up of the CRAMSS user interface (Collapsing aligned widgets)

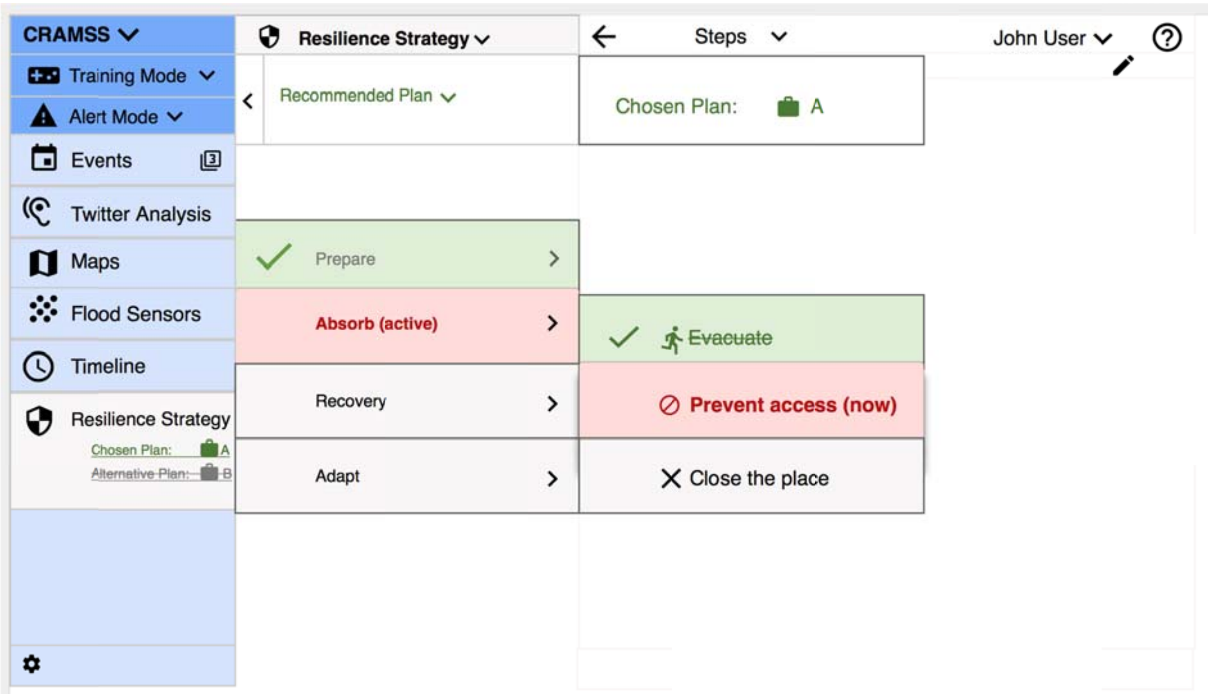

Figure 6 – Primary mock-up of the CRAMSS user interface (prediction based priority alignment function)

3 EMERGENCY SUPPORT SMART MOBILE APP

The Emergency Support Smart Mobile App (ESSMA) will be the front-end interface for communicating both, personalized messages and also generic notifications directly to the public. The ESSMA will have rather limited processing capabilities due to the low energy consumption requirements of the mobile devices. However, some light-weighted processing will still take place on ESSMA. Most importantly, it will focus on the smooth and user-friendly delivery of the resilience-oriented information to the end user taking into account the personal profile of the latter though advanced and highly comprehensive visualizations in the most language-agnostic way (e.g. maps, signs, alerts, graphics, sounds, vibrations, etc.). Last but not least, it should be noted that the ESSMA will host personalized information about the user of the mobile device and will communicate and exchange data with the rest of the system, mainly over the CRAMSS platform.

The Emergency Support Smart Mobile App (ESSMA) is meant to be used by both, professionals such as employees of the UTS, and civilians. In case of the civilians, it follows two main purposes: one is to track user movement and behaviour and thus provide the CRAMSS with data on a level of detail that could not be achieved otherwise. The other is to provide each user with individualized information, aiming to support self-rescue or to divert passenger flow in the UTS in case of a disruption. Professionals will, apart from being tracked just like civilians, receive information about the nature of a disruptive event once it has happened, and what can be done to manage the situation.

The ESSMA is, obviously, not a system to substitute other safety-relevant installations, such as exit signs in public buildings. It is meant to provide an added value to those who have it, while during its possible failure, e.g. when mobile communication breaks down, (self-)rescue should still be possible based on established and compulsory safety installations and routines.

3.1 Target users

The target groups meant to make use of the ESSMA are civilian users and rescue professionals; these two main user groups may be divided into several sub-groups that may use the app for different motives, or that may play different contents on the app, according to their role in real disruptive events. For example, civilian users may only receive information relevant for their self-rescue, whilst rescue professionals may receive additional information on what is going on where they are headed to help civilians. Civilian users of the ESSMA and consequently of the GBTA as well, may vary in age from 14 years to old age. Younger users would supposedly need a separate app, which is not foreseen within the context of this project. Some civilian users are characterized as "ad-hoc volunteers" (GA, p. 131) if they have a certain user profile that qualifies them for such a task; they therefore constitute a subgroup of the civilian users. These roles will be assigned to the users, partially based on the user profile entered in the ESSMA and partially based on outcomes of the use of the GBTA: being an ad-hoc volunteer may, for example, require having successfully finished a certain game-based training.

Although rescue professionals can belong to different organizations yet they share common characteristics: A professional training with respect to rescue activities and a more restricted age span (from 18 years of age to retirement age).

Thus, the users of the ESSMA can be summed up as:

1. Civilians / Citizens (age 14-99)
    - Passive role (to be rescued, if necessary)
    - Potential active role (can uptake the informal active role, if trained)
    - Informal active role (can be an ad-hoc rescuer, if necessary)
2. Rescuers (formal active role)

- UTS employees
- Emergency rescue teams
- Civil protection agents

While the rescuers are expected to be proficient at the locally spoken language, some civilians may have a migration background and need a user interface in another language.

3.2 Scope and objectives

The objectives of the ESSMA's users are:

1. Self-rescue in case of disruption/emergency with the support of the ESSMA (civilians)
2. Follow alternative routing in case of disruption for users that are not (yet) in acute danger due to the disruptive event, as provided by the ESSMA (civilians)
3. Find the target of rescue or mitigation – i.e. civilians to be rescued or problems to be fixed – with the support of the ESSMA, including info on exit route(s) (rescue professionals).
4. Get information on how to fix a problem (rescue professionals, UTS employees).
5. Get information on location and status of important peers, such as siblings, children, parents, etc. (for civilians; to provide an incentive for installing the app).

"The messages forwarded to the people (early warnings, alert, directions, etc.) are tailored according to their profile" (GA, p.139).

3.3 Features

This section provides an overview on the technical features of the application. Some features may be relevant for the definition of the UI, although they do not directly (only indirectly) contribute to achieving the user's objectives. An example of this is the locating function of the ESSMA, which helps rescue activities but is (possibly) not directly desired by the user.

With respect to the four cornerstones of resilience, the ESSMA principally supports the function RESPOND. In the emergency situation, the ESSMA helps speeding up the rescue of travellers by telling travellers how to escape and rescuers how to find the people to be rescued. The ESSMA may provide travel suggestions for non-affected people, thus resulting in a higher efficiency in the UTS and consequently a quicker or better recovery from disruptive events. Such advice can be given not only shortly after an event but also in medium-term and long-term aftermath.

General features:

1. Registration (including an identification procedure for authorized persons, such as emergency teams).
    a. First Aid education level
    b. Group (e.g., fire brigade, police, UTS employee)
2. Login (necessary to differentiate which information to make accessible to which user).

Features for professional users:

1. Display "all the relevant information about a problem state and how to [obtain further information required to resolve a problem]" (GA, p. 108).
2. Display nearest currently available emergency exits.
3. Display relevant POIs and how to reach them (fire extinguishers; first aid kits, position of people to be rescued, etc.). → Execute indoor-/outdoor navigation ("real-time evacuation guidance")

Features for civilian users:

1. Collect the user's localization data in real-time and send it to the back-end for various purposes. → "sensing in background the human movement behaviour" (GA, p. 152)
2. Display information on disruption / emergency (push-message)
3. Display information info on how to self-rescue ("real-time evacuation guidance", GA, p. 108)
   a. Realization option 1: Short (!) text message
   b. Realization option 2: Indicate escape route on an (indoor-/outdoor) navigation map.
   c. Realization option 3: Use Augmented Reality (AR) to display an arrow pointing in the direction of escape (through the camera-view of the smartphone).
4. Display information to rescuers with problem state info (plus advice on countermeasures). This involves a security issue: sensitive data may not be shared with not-trustworthy persons.
5. Provide localization of people to rescuers
6. Provide additional info on location, including exits.
7. Provide / collect "self-reporting" data (T4.4) for the CRAMSS?? Collect "skill information" about users?
8. Create user profile
   a. Age (elderly → movement capacity, children → power / responsibility)
   b. Limitations: mobility impairments, vision impairments, hearing impairments (y/n).

It may be necessary to include one or more features that provide an added value to the users, to promote the installation of the app. Emergency functions alone may not suffice, as some users may assume they will unlikely be affected by emergencies. An example of such a feature may be:

9. Displaying the location of relevant persons during emergencies (e.g. children, siblings, etc.).

3.4 User requirements

General requirements are the fulfilment of established user interaction guidelines, such as Nielsen's usability heuristics (Nielsen, 1999).

3.4.1 Based on the target user description

1. Both user groups, rescuers and civilians with a passive role, require the ESSMA to be available in their local language. Additional languages would be nice to have; at least an English version for users that are non-proficient in the local languages of the pilot sites is required.
   → Languages: ENGLISH, GREEK, ITALIAN
2. The ESSMA must work for different age groups. Younger generations growing up with digital technologies can be expected to be well-accustomed to map-based applications, mobile navigation aids and interaction principles. Less technology-appraising users may have a smartphone yet encounter difficulties with understanding what the application may demand from them in an emergency situation.
   → Use simplified, commonly known interaction principles.
3. Clustering the Civilians into different groups requires collecting personal information. Both, GBTA (see below) and ESSMA need the same personal information. Instead of asking the users to complete two similar or identical user profile, the two apps could interchange this data. This has to be done in a manner that respects data privacy regulations: The users have to opt in to transfer their profile from the ESSMA to the GTBA, or from the GBTA to the ESSMA.
   → Avoid double-input of personal data in GBTA and ESSMA.

3.4.2 Based on the objectives

1. The foremost objective of the ESSMA is self-rescue. Everything is meant to be secondary. Thus, in an emergency situation, the self-rescue should be prompted.
   → Focus on efficient self-rescue as primary objective

3.4.3 Based on standards and the ERMG

The ERMG name key standards to be heeded in UI design of the ESSMA:

1. “Applications provided to the users should undergo usability testing to ensure their helpfulness during emergency situations” (D3.5, p. 71). This is addressed through the work plan for the development of all WP5 applications, including the ESSMA.
2. “Select communication methods by their scalability and sustainability” (D3.5, p. 71). This has to be addressed both on the technical side (WP4 and T5.3), as well as in the usability engineering.
3. Based on NUREG/CR-5680 (U. S. Nuclear Regulatory Commission, 1994), implications for the design of the ESSMA were summed up in Table 7.

Table 7: Environmental conditions; their impact on ESMA users and implications for ESMA

Environmental condition	Guideline(s)	Implications for the CRAMSS
Vibration	* Whole-body vibration can cause discomfort. * Whole-body vibration can adversely affect manual tracking. * Whole-body or object vibration can blur vision and interfere with visual acuity.	The user interface should be adapted to ongoing vibration by enlarging buttons and text, multimodal display of alarms and information (vibration cues might be not perceivable, if the user is in a condition where whole-body vibration are faced.
Noise	*Noise disrupts communication by obscuring speech, alarms, or other important sounds. When communication is impaired, task performance can suffer. * Noise directly impairs performance of simple and complex tasks. * Noise is annoying. Annoyance, in turn, can impair task performance. * Noise induces short-term hearing loss, or temporary threshold shift (TTS), which can interfere with task performance by making it difficult for workers to communicate.	If ESMA user are in a noisy condition the application should adapt itself by increasing the sound level of alarms the usage of visual cues for alarm indication (e.g. flashing display).
Heat	*Heat can make workers uncomfortable. * Heat can affect perceptual/motor tasks, again leading to errors. *„Heat can affect performance of mental tasks involving attention, memory, verbal reasoning skills, logic, and arithmetic and lead to errors. * Excess exposure to heat can cause heat stress. In the beginning stages of heat stress, a worker can become confused and can perform actions that may be detrimental to system safety.	The user interface of the ESMA should be designed in a way that it is usable with protective gloves
Cold	*Workers react to cool temperatures by	The user interface of the ESMA should provide

Environmental condition	Guideline(s)	Implications for the CRAMSS
	experiencing mild discomfort. At colder temperatures, manual dexterity is impaired. *Extreme exposure to cold can lead to hypothermia. Hypothermia, besides threatening a worker's life, can cause confusion and clumsiness, which may lead to errors	active button areas that are larger than the button to assure that the user can press the button even in case of extreme cold. Also the sensitivity of the display could be increased
Lighting	*Poor lighting can reduce visibility, making it difficult to see. *"Poor lighting can affect workers' ability to discriminate among colours. * Poor lighting can induce glare, which is annoying and impairs vision. *Flickering lights can also cause problems in performance.	The application should adapt itself to a good illuminance level.

Additionally, several standard guidelines apply to the design of mobile applications. These guidelines apply to the ESSMA, equally as to the GTBA and are therefore reported in the Annex.

3.4.4 Based on the features

1. A key challenge in the design lies in the fact that the most critical feature (self-rescue) of the ESSMA will only be available in an emergency situation. Although users are supposed to learn how to use this feature in the Game-Based Training App, the ESSMA should be designed in a way that accounts for a possible lack of such training.
→ Ensure navigation of the ESSMA is learnable during normal mode, e.g. by providing routing in non-emergency situations.

3.4.5 Based on research and other relevant aspects

1. Based on literature (Zipf & Mohan, 2008) the SAVE ME project (Jiménez Mixco & Evans, 2009) found the following key criteria for designing evacuation maps.

   a. Completeness: The map needs to contain all information required for finding the way out.
   b. Flashbulb time: The time the user requires to scan the map and internalize it should be short.
   c. Visual clutter / perceptual quality: Potentially distracting graphical content should be avoided, as it also implies a high flashbulb time.
   d. Symbol clarity: Symbols should be self-explicatory or generally well-known. Iconicity is expected to be helpful.
   e. Consistency: Particularly, the same symbols found by the user along the way should be easily recognizable as the same.

   If a map is used for explaining the escape route to the user, these principles need to be heeded. While this requirement principally refers to the passive role users, it would supposedly be wise to apply the same to maps provided to rescuers.
   → Make maps complete and consistent with the environment, with low flashbulb time, low visual clutter, and clear symbols.

2. According to the SAVE ME stakeholder research (A1.2 stakeholders report), rescuers need complete information, which rather means rich than more information. Rescuers should have access to different sources of information and verify themselves where. Access to first-hand information should be provided directly, to ensure this.

→ **Rescuers should get access to rich information relevant for their purposes.**

3. A basic approach to way finding processes is given by Downs and Stea (1977; c.f. SAVE ME A1.2 Stakeholders report), who differentiate the following four sub-tasks of a person trying to find an exit:
   a. Orientation, i.e. determining one's position in an environment,
   b. Choosing the route, i.e. planning one's route to the destination,
   c. Keeping on the right track,
   d. Discovering the destination.

   Depending on the navigation concept to be implemented, different combinations of these sub-tasks may become particularly relevant for the HMI design. In a landmarks-based approach, the minimum requirement is for the user to identify the direction, landmark, door, etc. to move towards from the current position; getting there, the next landmark. An approach without landmarks requires other methods for insuring that the user keeps on track (and knows that she remains on track) until reaching the exit.
   → **Emergency navigation should help users identify the direction of movement and feedback on the correctness of the escape route chosen.**

4. Mass panic:
   Psychological research (Cocking, Drury & Reicher, 2009) indicates that in emergency situation, people do not tend to panic and thus behave irrationally, simply due to fear. Instead many people have in emergencies been reported to keep their calm and to behave cooperatively, even among strangers. The true danger of so-called "mass panics" is due to bad front-to-back-communication. This means: people pile up as the back of a crowd cannot realize that the front of the crowd has stopped moving, e.g. because of being confronted by a barrier (e.g., the Love Parade disaster of Düsseldorf, Germany, 2010). This requires decision making routines not to send too many persons into the same area. GUIs simply have to be designed in a way that ensures people get clear information about what to do, in order to make them feel capable of rescuing themselves and others. Additionally, it is known that people sometimes disregard orders given by station personnel or even police; the system needs to take disobedience into account and phrase self-rescue orders in a way that transports the authority of the sender.
   → **Avoid mass panic by carefully dispersing people across exits or areas and ensure that self-rescue information is clearly stated. The authority of the sender should be transmitted.**

3.5 Technical restrictions

The app will be developed for two mobile platforms: Android OS and iOS. The resulting restrictions are:

- **Interaction is limited to**
  - Touch-screen interaction
    - Single clicks
    - Gestures
  - Sensor input
    - Locomotion (location sensor)
    - Pointing / directing the phone at something (gyroscopic sensors)
  - (possibly: speech/sound input)
- **Limited screen size**
  - Reference: iPhone 4 (3.5 inch; 960 × 640 pixels)
  - Reference: Android phone: reference device not yet defined.

3.6 Work plan: user requirements analysis

The most important questions to be answered by the user requirements analysis for the ESSMA are the following:

1. Which attitudes do users in the pilot cities (Florence and Athens) have towards mobile apps for navigating their city's traffic and for taking care of their own security?
2. Which similar apps are used and known – and have shaped their mental models of such apps?
3. How could such users be motivated to use the ESSMA?
4. Which interaction concept for self-rescue is preferred (augmented reality, map-based, landmark-based, or else)?
5. Which components of the app are requested?
6. Which behaviour of the components is requested?
7. What is particularly to be avoided in the interaction design?

Answering these questions requires clarifying attitudes in depth, gathering qualitative information about prior experiences, and possibly experimenting with first drafts of a design (e.g., paper mock-ups). All of this can best be achieved using a focus-group approach. Per pilot site, two focus group sessions should be done, each with a group of 8-10 users. The users should include elderly people, parents, and younger adults (e.g. students). In the best case, people with walking disabilities are also included.

3.7 Blueprint of user interaction & experience

The starting draft of the ESSMA's UI structure is the following:

3.7.1 Draft structure

The ESSMA may need two modes, a normal mode and an alarm mode. This could help direct the user towards the currently important features, hide less relevant features or simply account for the circumstance that information such as an evacuation plan will only be available when the CRAMSS is in alarm mode. It is important to have the interaction in both modes be as similar as possible, so the user will not be confused by a different menu structure or app behaviour.

For example, the link to the self-rescue function could be available but greyed out in normal mode. It could also lead to an example page showing what the escape plan could look like and place a hint to the GBTA which can be used for training the use of the ESSMA without requiring a real emergency situation.

The following menu structure will serve as a starting point for subsequent user requirements research and/or testing:

1. Main menu:
   a. "Self-Rescue" / "Emergency assistant"
   b. (See messages – if advice is given through messages)
   c. ("Help others"; only available for rescuers)
   d. Locate my friends (locate relevant peers)
   e. Traffic guide (provides info on how to avert traffic jams, etc.; real-time info on disruptions)
   f. My profile
   g. Exit (*if necessary, depending on platform*)
2. "Self-Rescue" / "Emergency assistant"
   a. List of (active) messages received

   b. Navigation information to nearest exit / or: route to safety, out of the danger-zone (e.g. in case of water bomb).
3. (“Help others”; only available for rescuers)
   a. List of (active) messages received
   b. Navigation information to relevant person to be helped or rescued
4. Locate my friends (locate relevant peers)List of achievements
   a. See position and status of connected users on a map.
   b. Add new friends / authorize localization feature to show own position to other registered users.
5. Traffic guide
   a. Option 1: See messages about disruptions (e.g., “bus line 107 delayed due to road accident”.)
   b. Option 2: Enter a destination and receive a routing proposition, based on the real-time data.
6. My profile
   a. Edit user profile (possibly including a feature to add an authorisation code that enables receiving information for professional rescuers, such as fire brigades, civil protection, etc.)

An alternative design would divide the functions in the ones available in normal mode (locate friends, traffic guide, profile) and alert mode (self-rescue, help others, traffic guide, locate friends).

3.7.2 Design of the self-rescue navigation

A key element in the ESSMA is the way self-rescue information is conveyed to the users in a case of emergency. Two different scenarios can be distinguished:

1. Street- or network-based navigation: this resembles the travel guide and can even use the same user interface. The users need to be redirected on a city- or street-level of detail. As an example: A water bomb situation has occurred in the pilot city of Florence; as a consequence, several streets in a district of the city are flooded and are being evacuated. Traffic has to be redirected to avoid this area and also the safe spots or “gathering areas” close to the flooded area where people are being evacuated to. People outside the critical area will, when wanting to travel from one side of Florence to the other, receive a different routing proposal, based on which nodes are blocked. Such a navigation feature should probably be done similar to commonly known map-based navigation apps, such as google maps. It could consist in a list of navigation commands (“turn left at the next crossroads”), or as a line drawn on a map, lighting up the correct streets to take.
2. Navigation inside a critical infrastructure: If getting to safety means finding the best way towards the most recommendable exit (e.g., “the nearest” or “the safest”) from inside a critical infrastructure, then indoor navigation is required. In the example of the metro station, one should take into account that also evacuation by metro is an option, e.g. if the way to the surface is blocked (e.g. in case of a fire on a superior floor). While in all scenarios, connectivity loss is critical, it is particularly important in indoor navigation scenarios. Although a resilient router network technology was developed in the SAVE ME project (Grant Agreement No. 234027 of the European Commission), this may not be available everywhere the RESOLUTE system is about to be installed. Thus, the user interface needs to react to connectivity loss, e.g. by displaying general information to keep calm and proceed to the nearest exit. Various types of indoor navigation are available and the type and thus level of selected depends on user requirements, as well as on technical restrictions in the system used. The following approaches are possible:
   a. Naming the exit. This option simply consists in sending a message that names the exit to take, e.g. represented by the street names surrounding the exit. In metro stations around the world, exits are often signalised in this manner – and signs inside the stations lead to those exits. This option does not require highly reliable position information and not much preparation,

compared to the other methods. This increases the scalability of the system with respect to spreading it across different areas.

b. Providing waypoints on a map. This option consists in showing a map of the CI (which, of course needs to be previously available in a digital format) and showing the current position, the position of the exit and a line that connects them via the optimal path. Due to the three-dimensional structure of metro stations and other traffic infrastructures, this method may have drawbacks in how clear and easy to follow the information is.

c. Landmark navigation / slideshow navigation. The navigation consists in a slideshow of single navigation commands, connected to visible landmarks. After passing a landmark, the user continues to the next slide and receives the next hint. This concept was successfully field-tested in the SAVE ME project (Delahaye, Graf, Lemoine, Stucki, Mager, et al. 2009): even children were able to use it. However, the individual effort of preparing it for a specific CI is very high, compared to the other methods. This approach is represented in intended for development (see also Figure 19).

d. Augmented reality navigation. Using augmented reality, the mobile device could translate a waypoint-based navigation information in the following way: the mobile device switches to camera mode and displays an arrow or other navigation commands on the screen, embedded in the view of the surroundings. This method relies on compass- and gyro-sensors, as well as a map-representation of the CI, as it needs to create waypoints. The advantage is that it may be the easiest one to use for different user groups, it appears to be the most direct and intuitive type of interaction. Compared to the landmark approach, it does not (possibly) require navigating between different slides.

In Figure 7 to Figure 11, examples of what such guidance content could look like are displayed.

Figure 7 – Street- or network-based navigation

Figure 8 – Naming the exit

Figure 9 – Waypoint navigation (indoor)

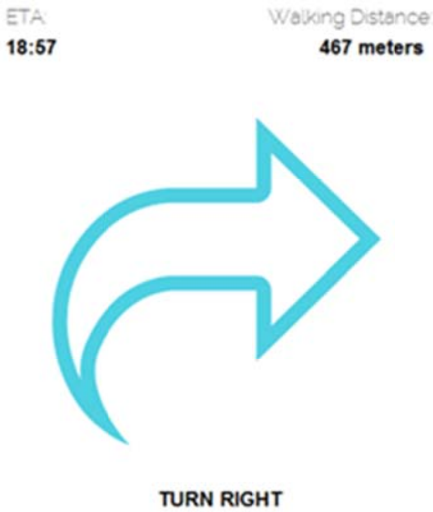

Figure 10 – Landmark / slideshow navigation

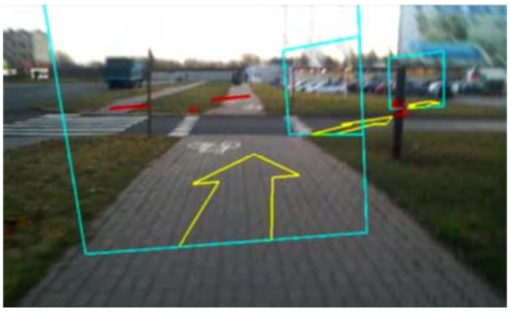

Figure 11 – Augmented reality pedestrian navigation (M-Inclusion project)

3.7.3 Scribbles

Scribbles are early, low-fi representations of graphical user interfaces or interaction concepts. As they represent a starting point for development, they will most likely change regarding several of their characteristics. Thus, it is not reasonable to produce hi-fi drawings at this early stage.

Figure 12: ESSMA – first draft of the start page

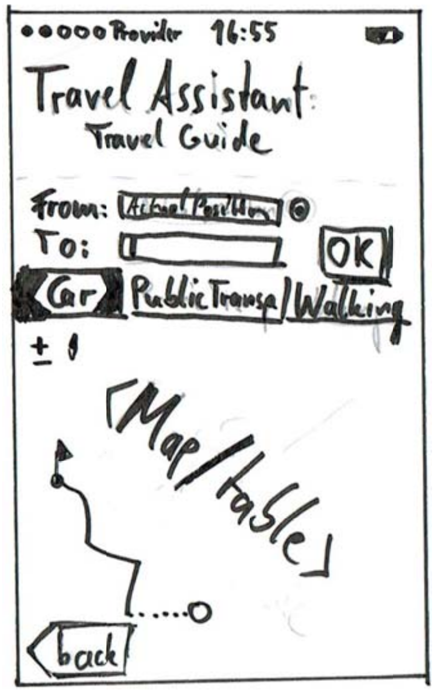

Figure 13: ESSMA – first draft of the travel guide

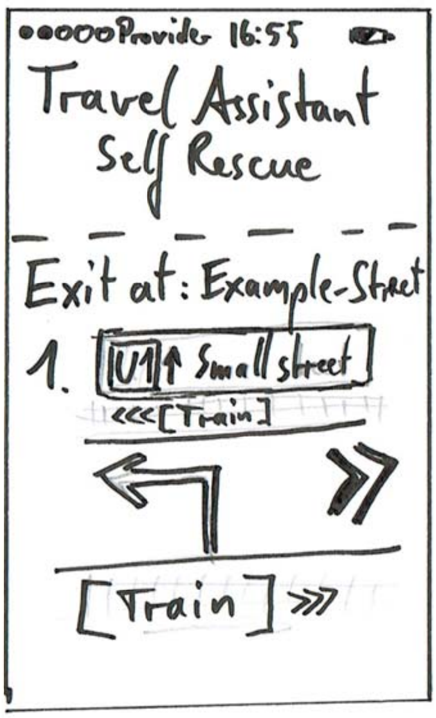

Figure 14: ESSMA – first draft of the self-rescue feature (based on landmarks)

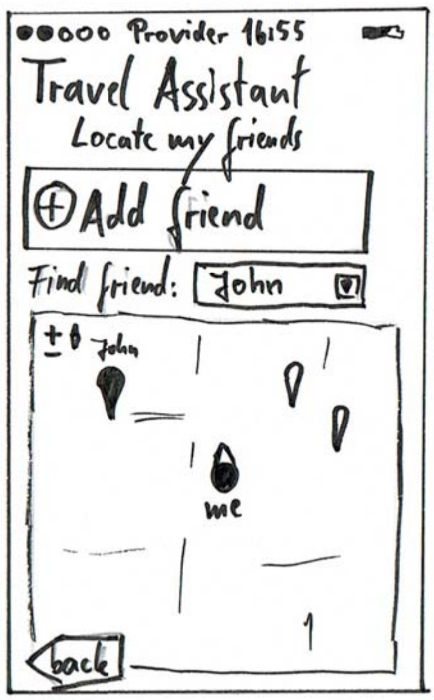

Figure 15: ESSMA – first draft of the find-my-friend feature (added value feature)

3.7.4 Primary mock-ups

Mock-up creation has started and is ongoing.

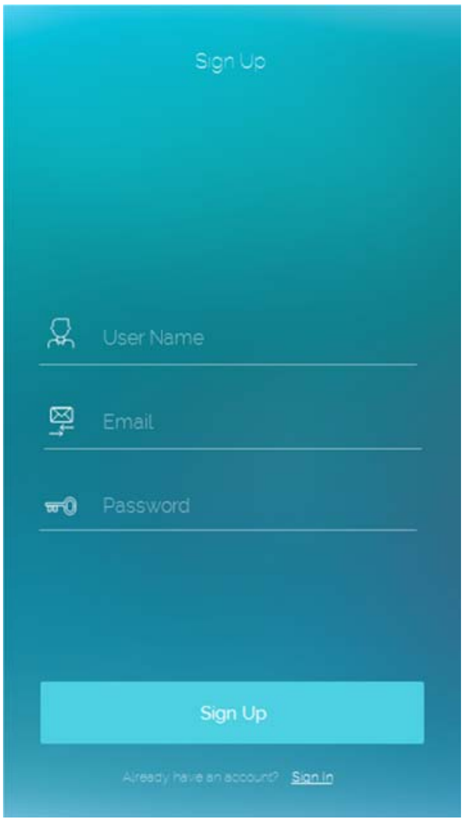

Figure 16 ESSMA – sign up page

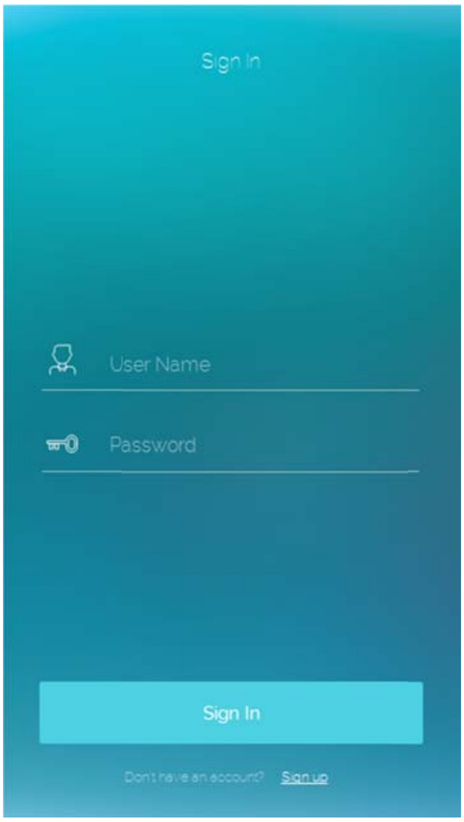

Figure 17 ESSMA – sign in page

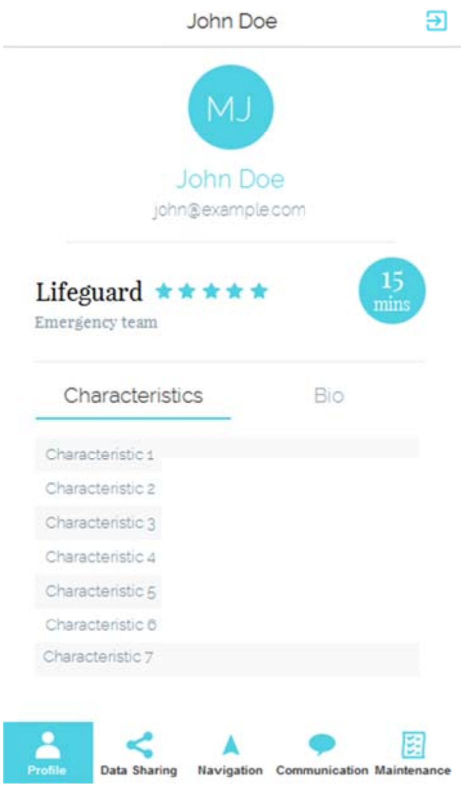

Figure 18 – ESSMA user profile (draft)

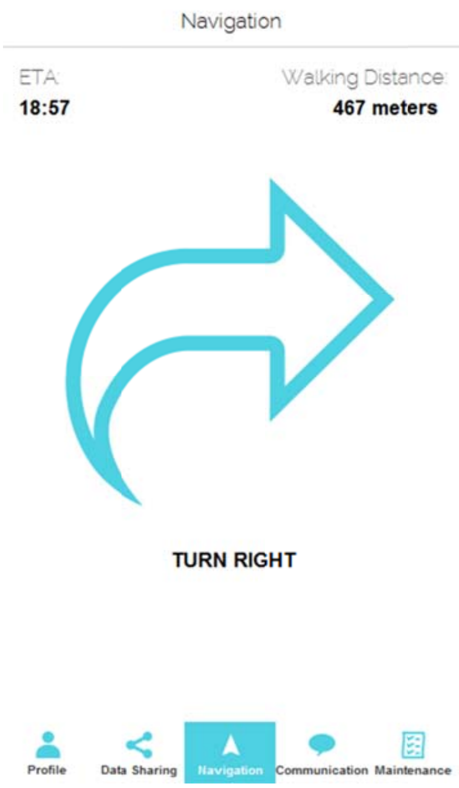

Figure 19 – ESSMA navigation page

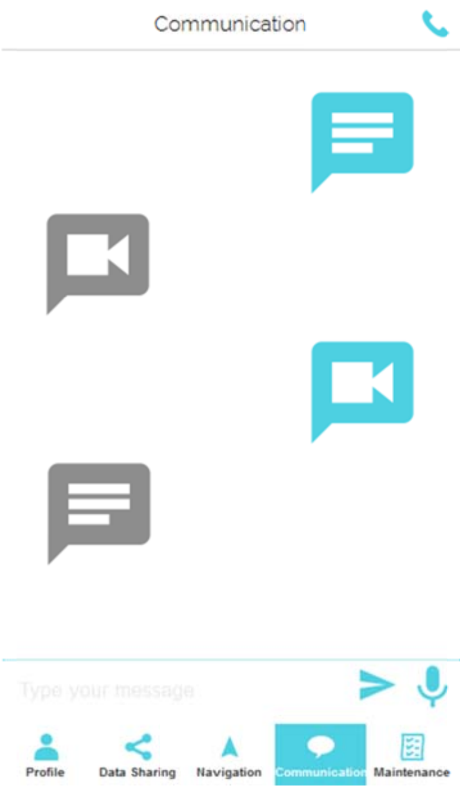

Figure 20 – ESSMA communication

Figure 21 – ESSMA file sharing

4 GAME-BASED TRAINING APP

The Game Based Training App (GBTA) is a meta-app that loads and executes different game schemas, depending on user profile and training programme selected by / for the respective user. It also evaluates the results of the user when or after interacting with the training. The training contents are being developed based on the state of the art concerning training and game-based learning in the area of public safety and resilience of socio-technological systems. The state of the art also discusses training evaluation criteria (D2.1).

The GBTA will be developed for the mobile platforms Android OS and iOS and serve the civilian users and rescuers in learning how to use the ESSMA in normal operation conditions and in emergency situations. The main objective behind providing the training app is to ensure that the ESSMA will fulfil its presumed role of improving the resilience of the respective city's UTS by redirecting passenger flow and aiding in rescue operations (see Project objective 4, GA p. 132).

The game-based training app will also monitor the training success of its users, e.g. by determining a learning curve. This information is provided to the CRAMSS operator, so that new training objectives or materials can be defined if necessary. This monitoring method will be re-used for evaluating the training process of infrastructure managers or operators using the CRAMSS training modules available in the CRAMSS.

4.1 Target users

The target groups meant to use of the GBTA are the same as the users of the ESSMA:

1. Civilians / Citizens (age 14-99)
    - Passive role (to be rescued, if necessary)
    - Potential active role (can become informal active role, if trained)
    - Informal active role (can be an ad-hoc rescuer, if necessary)
2. Rescuers (formal active role)
    - UTS employees
    - Emergency rescue
    - Civil protection agents

Consequently, the same restrictions as mentioned in the chapter 3 will also apply here.

4.2 Scope and objectives

From a user's perspective, the game-based training app is meant to be a fun activity and to prepare the user for using the ESSMA application.

The single objectives of the user are:

1. Select my training from a list of options and execute the training; pause or restart/repeat if necessary.
2. Master the training
3. Receive my rewards
    a. Unlock harder trainings
    b. View my achievements
    c. Publish an achievement via social media

The content of the trainings has yet to be decided, a preliminary list of training contents (which represent the target users' possible learning objectives) are:

Passive role (available to all users):

- Learn to navigate the ESSMA app; access different areas and features.
- Learn to read warnings about service disruptions or emergency situations
- Learn to adapt a route based on recommendations given by the ESSMA.
- Learn to use the ESSMA for escaping a confined place, such as a metro station.

Potential active role (available to all users who meet defined characteristics and who have mastered the trainings in the passive role):

- Repeat all trainings from the “passive role” block
- Learn how to deal with a help request as an ad-hoc rescuer.
- Learn how to locate people to rescue and the proposed exit.
- Pass a test on rescue-relevant background knowledge.
- Pass a test on first aid techniques.

Informal active role (available to all users who meet defined characteristics and who have mastered the trainings in the potential active role)

- Repeat all trainings from the “passive role” block
- Repeat all trainings from the “potential active role” block

Formal active role:

- The same trainings as the “potential active role”,
- Additional trainings for professionals which are not available for civilians (such as finding hydrants) or equipment in metro stations using the ESSMA.
- Meta-competences, such as stress resilience (Weltman, Lamon, Freedy & Chartrand, 2014) or decision making skills for non-equilibrium situations (Rahman, Grossman and Asken, 2008). (GA, p.151).

4.3 Features

With respect to the four cornerstones of resilience, the GBTA supports the functions PLAN and ADAPT.

- ANTICIPATE: Through providing training to its users before disruptive events happen, the GBTA aids in preparing the UTS and its users for such events.
- LEARN: New trainings may be created as a reaction to the lessons learned, e.g. after a disruptive event. Such trainings increase the resilience of the UTS by strengthening external elements (the users) who are of critical influence and generally less easy to reach.

The GBTA will, from a system point of view, include the following features:

1. Background feature: Import user profile from ESSMA
2. Create list of available trainings based on the user profile
3. Display available trainings as a list of options
4. Execute the selected training;
5. Provide a pause or restart/repeat if necessary or adequate.
6. Evaluate training success
    a. In a single training
    b. Over the course of time if trainings are repeated or between training levels in the same area of contents (“learning curve”)
7. Provide a categorization of the civilian user (passive; potential active; informal active) to the ESSMA, based on the training status and person characteristics.
8. Unlock trainings under given conditions

9. Unlock achievements (e.g., medals) or grant rewards. Include a social media feature for sharing achievements.

4.4 User requirements

Similar to the requirements of the ESSMA, established user interaction guidelines, such as Nielsen's usability heuristics (Nielsen, 1993) need to be heeded as a basic requirement.

4.4.1 Based on the target user description

1. The GBTA must be available in the local language for all rescuers and the majority of the civilians. Nice to have would be other languages, at least an English version for users that are non-proficient in the local languages of the pilot sites.
   → Languages: ENGLISH, GREEK, ITALIAN
2. The GBTA must provide incentives that work for different age groups. Younger generations growing up with digital technologies can be expected to be well-accustomed to mobile games. Representation of rewards and achievements must meet their expectations to be interesting. Adults at a more progressed age may possibly rate the usefulness of the training more important than the game-specific characteristics.
   → Up-to-date reward system; market obvious usefulness.
3. As explained above, in the chapter about the ESSMA, both mobile RESOLUTE apps should share the user's profile among them to minimize work for the user and to avoid errors due to inconsistencies.
   → Avoid double-input of personal data in GBTA and ESSMA.

4.4.2 Based on the objectives

1. Provide the same user interface as the ESSMA (so users can directly apply what they learned; see Objective 4, GA, p. 149) while making sure that users can distinguish between training and real emergency.
   → Re-use ESSMA user interface while indicating the training character.

4.4.3 Based on the features

1. As a conclusion of the preliminary list of features, the app appears to require the following menu structure.
   → Main menu; achievements; list of trainings; training execution

4.4.4 Based on research and other relevant aspects

1. The GA names five key characteristics that the GBTA should fulfill. These are:
   a. Compelling content
   b. Clear emphasis on practical application
   c. Interactivity and experimentation
   d. Genuine skills development through practice and feedback
   e. Motivation for people to learn and, above all, to complete the course they begin.

   Thus, they constitute requirements, which partly have to be fulfilled by the UI concept; "Compelling content" and "emphasis on the practical application" should be transmitted via the content itself. However, the UI / presentation needs to make sure the GBTA trainings are interactive and allow for experimentation. That means that the trainings should not be a mere presentation of what has to be done. In the best case, the game scenario is not linear and allows for different approaches or sequences of action to solve the given problem. It should require input by the user (see technical requirements for

limitations on interaction). Feedback needs to be provided by the app, optimal learning requires a timely feedback directly after acting/answering, e.g. by sound, pop-ups, etc.
→ Interactive learning: user input to solve game challenges; timely feedback (right vs. wrong)

2. Additional research should be done to find out where and when the training app is likely to be used. The content and the interaction principles should be oriented at the situation of use.
Scenario 1: Playing in the leisure time while travelling on the public transport (metro or bus). Available time frame: 5 – 30 Min.
Scenario 2: Waiting in a line / waiting office / etc. 5 – 60 Min.
Scenario 3: At school, as an educational activity guided by the teacher. 15-20 Min.
→ Design the app (pausing, restarts, etc.) for use in gaming-prone situations: Include operators to pause, restart/repeat.

4.5 Technical restrictions

The following technical restrictions are the same as mentioned above for the ESSMA, as the GBTA serves to train users for using the ESSMA. Consequently, the GBTA needs to run on the same devices and thus encounters the same technical restrictions.

The app will be developed for two mobile platforms: Android OS and iOS, "using state of the art technologies and open source frameworks." (GA, p.108)) The resulting restrictions are:

- Interaction is limited to
    - touch-screen interaction
        - Single clicks
        - Gestures
    - Sensor input
        - Locomotion (location sensor)
        - Pointing / directing the phone at something (gyroscopic sensors)
    - (possibly: speech/sound input)
- Limited screen size
    - Reference: iPhone 4 (3.5 inch; 960 × 640 Pixel)
    - Reference: Android phone not yet selected.
- The ESSMA needs to have been installed and fed with personal data previously

4.6 Work plan: user requirements analysis

The GTBA appears to require a rather not-complex user interface structure. The main challenge lies in the design of the training contents, not the app itself. The most important training content – how to use the ESSMA self-rescue feature – depends on how this feature is going to be implemented (see above). The key questions to answer in the user requirements analysis for the GBTA are:

1. Which training contents should be included in the first version of the GBTA?
2. Which training method should be used for which content?
3. Do we need to create a guide for future users on how to add new contents?
4. Which kinds of achievements are particularly interesting for which user group?
5. When, how and why would which users use the app?

Based on these questions, the most adequate method seems to be a combination of a design thinking approach, based on a team of experts drafting the app and its contents together, and a focus-group approach to find out about the motivations of the users to use the app and how to strengthen or support these motivations with the interaction design. As the users are the same as those of the ESSMA, the focus-groups could be joined to increase the efficiency of the procedure.

4.7 Blueprint of user interaction & experience

The starting draft of the UI structure is the following:

4.7.1 Draft structure

The following menu structure will serve as a starting point for subsequent user requirements research and/or testing:

1. Main menu:
    a. Start training
    b. Repeat training
    c. View achievements
    d. Options
    e. Exit (*if necessary, depending on platform*)
2. Start training
    a. List of trainings available which had not been concluded before
    b. List of trainings available which had been concluded before
    c. (Navigation elements: back; stop training; restart training)
3. View achievements / “My medals” / …
    a. List of achievements
    b. Functions for sharing on social platforms
    c. (Navigation elements: back)
4. Options
    a. Select language
    b. View user profile imported from ESSMA
    c. (Navigation elements: back)
5. Info
    a. Version info; publisher; contact

4.7.2 Scribbles

Scribbles are early, low-fi representations of graphical user interfaces or interaction concepts. As they represent a starting point for development, they will most likely change regarding several of their characteristics. Thus, it is not reasonable to produce hi-fi drawings at this early stage.

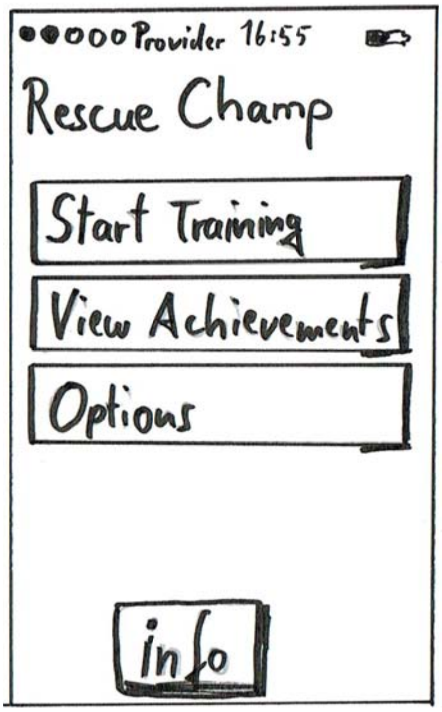

Figure 22: GBTA – first draft of the start page

Figure 23: GBTA – first draft of the trainings list

Figure 24: GBTA – first draft of the achievements page

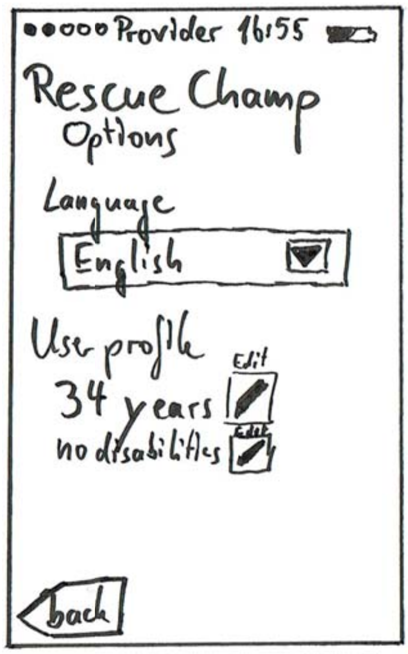

Figure 25: GBTA – first draft of the options page

5 CONCLUSIONS

This deliverable provides a basis for streamlined and coherent work in workpackages 4 and 5. It sums up the main target user groups and their characteristics, as well as the features and contents and the conditions of the WP 5 applications.

It is a living document and presents a work in process. It is expected to change over the course of WP5. It picks up and translates terminology, concepts, models and theoretical approaches described in other workpackages and transforms them into drafts of a varying degree of detail. In this way, the deliverable itself is part of a design thinking process that involves all RESOLUTE partners in order to result in a common perspective and problem understanding, developing new methods or creating solutions for both interaction design itself and the underlying functionalities and thus re-engineering the way resilience is thought and implemented at a short and larger scale in Europe's cities and particularly its critical infrastructures.

An updated and final version of this deliverable will be released in M22 and will contain a report of what has been done in WP5 and relevant reasoning in case single aspects may deviate from what was previously described.

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7 ANNEX I: ADDITIONAL SOURCES

7.1 Development of the CRAMSS

The CRAMSS will display different types of information to its user. The functionality of the CRAMSS and consequently its user interface are to a large extent influenced by the type of data available in the CRAMSS and the algorithms that process the data to provide the user with interpretations and conclusions. Most of this information is given in D4.1. Therefore, the currently known details on the information sources available through the CRAMSS are collected in this annex, rather than in the chapters above.

7.1.1 Contents of the CRAMSS according to the DoW

Direct quotations are indicated by inclined letters:

1. Data input: *municipality open data (including: seismic risk maps, hydrological risk maps, services, statistics, time series of major disasters, descriptors of structures such as schools, hospitals, infrastructures, mobility structure, streets and city services, etc.), mobility operators (public mobility operator timeline and real time status, taxi, parking areas (locations and status), Wi-Fi sensors (people flows), local sensors for car flows), user tracking flow (WiFi /Bluetooth).* (T4.2)
2. *Aggregation of available (Geo) Open Government Data (e.g. hydrological risk maps, etc.), exposures status data (traffic jam, the humans position, schools open, etc.), Big Data (e.g. river height sensor data, traffic data, statistics, etc.), social media data (twitter), public aggregate resources (CrisisNet, GDELT, etc.) through standardised contribution formats, APIs and processes in order to reconcile and integrate them in a unique semantic interoperable* (GA, p. 131 Obj3)
3. *Gathering of crowd sourced/sensed information flows - composed of smart device sensor data, annotations, comments, news about the city, geo positions - coming from citizens and visitors also during the emergency. Processing them with innovative tools, e.g. Natural Language Processing tools, Geo Clustering techniques, flow predictions and the like, to extract features, context, meaning, sentiment, and statements;* (GA, p. 131, Obj3)
4. *Implementation with standard thesauri and ontologies of a Knowledge base for Resilience Management (KRM) using the concepts defined in the ERMG extendable to all spatial data themes covered by INSPIRE directive and quality assurance (e.g. ISO19131) to link potential interactions /cascade effects of some risks, assets and systems with their status, etc.;* (GA, p. 131, Obj3)
5. *Supporting predictive models on infrastructure resilience combining Multiplex Social Networks for human behaviours modelling, Pattern Recognition, Statistical analysis approaches, and semantic processing;* (GA, p. 131, Obj3)
6. *Social dynamics and the human factor* (GA, p.140)
7. "*The Application Framework contains two components that intend to further refine and process the available data and mainly focuses on: managing user profiles and analysing cascading behaviour in UTS modelled network, predicting in time the evolution of the network itself and its resilience metric with respect to the degradation of service (effect) and not only node failure (both cause and effect)*" (GA, p.148). → Which user profile management activities does the operator need to do?

7.1.2 Contents of the CRAMSS based on primary discussions

Based on Face-to-face meetings with the urban police and civil protection of the City of Florence, the following types of data can be provided to or through the CRAMSS

- Position of the physical infrastructure of utilities
- Position and real time status (open, closed) of schools.
- Position of safe places / gathering spots.
- Vulnerability layers of buildings
- Estimated value of buildings
- Real-time position of the first responders on the ground and intervention status (start, ongoing, finished)
- Real-time position of the people (detected by a mobile app) on the ground
- Real-time management of the first responders team
- Real-time information about yards positions in the city
- Real-time information about the traffic status
- Real-time information about the public transport system (buses)
- Real-time information about the status of the situation provided by operators of different services
- Real-time data about urban Wi-Fi connectivity
- Real-time information from environmental sensors (river level, water level on underpasses) to monitor the dynamics of a flooding
- Real-time monitoring of twitter (sentiment-analysis, channels)
- Real-time information on volunteers available for civil protection
- Real-time information about the availability of the civil protection's emergency vehicles.

7.1.3 Summary of user requirements reported in D4.1

The following list of possible requirements partially coincides with what was collected above; other aspects cannot yet be specified, as relevant details of the back-end implementation are not known. These requirements need to be taken into account when further developing and revising the front-ends, and the development and testing methods depicted in this deliverable.

Table 8: D4.1 user requirements summary

ID	Conclusion from D4.1 with respect to WP5	Consequence
SoA_01	The information presented by the CRAMSS should "support coordinated and synchronised action and decision making".	This creates an evaluation criterion for the design of the CRAMSS
SoA_02	Context specific support is to be provided.	When the context is relevant for the interpretation of the decision support, such information must be provided.
SoA_04	"Monitoring and assessing the degree of accomplishment of planned operational objectives"	This may empower us to provide feedback also to the operator concerning the degree of fulfilment of the resilience strategy started.
USR_01	User privileges determine which controls are available	Log-in is required from the user. Credentials need to be managed. Different levels of control need to be defined by T4.1 (apart from control points; see USR_02)
USR_02 thru	Functions to add, update, enable, disable, or delete control	Define how control points are visualized

ID	Conclusion from D4.1 with respect to WP5	Consequence
USR_06	points are foreseen. Apparently, a control point is a rule that triggers a resilience strategy, based on defined conditions.	and manipulated by users with the respective permission.
USR_07	Control points (or types of them) can be displayed or hidden.	The map or any other display feature should enable the user to view or hide control points at will.
USR_09	Manual actuation means that resilience strategies that do not have any defined control points will always need to be triggered manually.	Above, it was already defined that any resilience strategy should be triggered by the user. The desired degree of automation has to be defined also according to the granularity of re-planning based on changing conditions in control points (see: minimum rest time).
USR_18	Control actions need to be assigned to each strategy.	The user needs an interface for manipulating actions.
USR_21	Activation triggers should allow for being monitored.	Possibly, variables depicted in the monitoring function (such as water level, number of cars, etc.) should be displayed in a way that shows how they are behaving with respect to activation triggers.
USR_26	A minimum rest time will ensure that resilience strategies are not changed too fast.	The rest time could be displayed to the user; in any case knowing this number will help in designing the interaction.
USR_34	"Users might be connected simultaneously (apart from the limits eventually set by common linking platform)"	It is crucial to ensure that the two users are not blocking or disturbing each other, e.g. through assigning privileges.

7.1.4 Use Cases of the CRAMSS

The following use cases were created for the development of the CRAMSS.

Name	Login to CRAMMS
Description	Only authorised operators are allowed to use the CRAMSS. Thus, the operator is required to log in in order to prove his/her identity. User name and password are provided by the administrators. The operator enters username and password in given entry fields and confirms the input. The system checks if the credentials are correct and either grants or denies the access depending on the result.
Primary actors	Operator Critical Infrastructure, Manager Critical Infrastructure
Preconditions	CRAMSS online and running; Operator has been provided with credentials (user name and password).
Result	The CRAMSS functionalities are available to the user. The user can open all CRAMSS widgets and web-based applications.
Application Scenario	The user wants to use the CRAMSS for any of the defined purposes.
Interaction Steps	Open respective CRAMSS secured website or login-widget Enter user name; enter password; confirm
Alternative paths	None
Comments	The contact to the administrator should be provided in case the operator encounters problems logging in.

Name	Assign Roles in the CRAMMS for ESSMA
Description	In an emergency event, different users have different roles: passive (unqualified civilians), informal active (qualified civilians) or formal active (police, ambulance teams, etc.). Each of these roles needs a different user interface and some information may be classified - thus, it is important to control who receives which role and information.
Primary actors	Operator Critical Infrastructure
Preconditions	CRAMSS is functional; user profile information of the ESSMA users are available, user logged in. Normal mode.
Result	A list or database is created or adapted to save the results of the assignment. The assignment of roles is taken into account in the selection of the resilience strategy and in the sending of messages to the persons in the list.
Application Scenario	The operator wants to make sure that all registered users with active roles receive the correct information.
Interaction Steps	1. The operator views a list of registered users, possibly with proposed user roles. 2. The operator selects or confirms each role by selecting one of the three roles (see DoW; D5.1) from a dropdown list.
Alternative paths	The operator creates a user profile for an active user, which contains the correct user rights.
Comments	-

Name	Monitor the status of the UTS
Description	This is a very broad type of use case, summing up a lot of different functionalities. However, it is highly important to the CRAMSS user. The user needs to access the monitoring functions in a way that suits the current objectives and situational task requirements. This demands flexibility in the system to display just the necessary information, without making cumbersome manual adjustments.
Primary actors	Operator Critical Infrastructure
Preconditions	CRAMSS is functional; monitoring data is received through the back-end; user logged in. Normal mode or alarm mode.
Result	The demanded monitoring data is viewed by the operator.
Application Scenario	Normal operations or alarm condition. The user wants to monitor certain process variables in the UTS in order to possibly adapt or reassign resources where necessary.
Interaction Steps	1. The user finds and selects the respective visualization feature (e.g. a map of bus positions in Florence) in a list of available monitoring features. 2. The system displays the required monitoring information in the respective format. If multiple formats are available, a widget or feature for switching between formats is displayed. 3. Optional: 3. On selecting an alternative display format, the format changes to the requested one. 4. On request, the respective monitoring window/widget/etc. closes. It is however still available for re-opening in the list of monitoring features.
Alternative paths	None.
Comments	In a multi-screen setup, the different monitoring features should be moveable and re-sizeable.

Name	Send messages to EMMS user
Description	To coordinate the rescue process, the CRAMMS operator sends messages to EMMS users with respective information about the evacuation strategy.
Primary actors	Manager Critical Infrastructure; Operator Critical Infrastructure
Preconditions	Operator EMMS connected to CRAMMS and reachable; emergency mode or normal mode of CRAMMS

Result	A message has been send with the respected information
Application Scenario	"A) The CRAMMS is in normal mode. The CRAMMS operater receives information about a signal loss on a sensor and wants to inform the respective IT department for checking the sensor. B) The CRAMMS is in emergency mode. The CRAMMS operater receives an alarm of a flooded tunnel and wants to inform the repsective operaters of the evacuation process"
Interaction Steps	1. The operator selects active users from a list or on the map and types a personalised message for this user or group of users. 2. The operator selects and confirms a resilience strategy. Automated personalized messages, according to the position and role of the user are sent automatically by the system. "
Alternative paths	Instead of using the CRAMSS, the operator contacts the ESSMA users via other channels, such as telephone.
Comments	-

Name	Start the alarm mode
Description	The alarm mode adapts the user interface to the emergency condition and thus actively supports the user in the most relevant tasks.
Primary actors	Operator Critical Infrastructure
Preconditions	User logged in, CRAMSS fully functional. Normal mode active.
Result	The CRAMSS goes into alarm mode.
Application Scenario	The operator wants to start the alarm mode because a disruptive event has been detected and has to be dealt with, e.g. using resilience strategies.
Interaction Steps	The operator uses the alarm mode switch on the main page or the main widget of the CRAMMS and confirms the alarm.
Alternative paths	The alarm mode is started automatically by the CRAMSS because an emergency situation was detected, e.g. through sensor data.
Comments	A security check with a timeout is necessary to ensure that the alarm mode is not started by accident.

Name	Stop the alarm mode
Description	The normal mode has a broader functionality than the alarm mode and is thus to be used in non-emergency situations, e.g. after a disruptive event has successfully been dealt with.
Primary actors	Operator Critical Infrastructure
Preconditions	User logged in, CRAMSS fully functional; alarm mode active.
Result	The CRAMSS goes into normal mode.
Application Scenario	The operator wants to end the alarm mode because the alarm mode is not needed anymore; e.g., a disruptive event has been dealt with.
Interaction Steps	The operator uses the alarm mode switch on the main page or the main widget of the CRAMMS.
Alternative paths	None.
Comments	-

Name	Start a resilience strategy

Description	Resilience strategies are processes specifically defined for certain onset conditions. They allow for a efficient reaction to a disruptive event through automated adaptation of the UTS and its connected systems.
Primary actors	Operator Critical Infrastructure
Preconditions	User logged in; CRAMSS fully functional; alarm mode active; at least **1** resilience strategy was previously defined, (CRAMSS DSS proposes a resilience strategy based on current data retrieved from the back-end).
Result	A resilience strategy is started. Resilience strategies may (depending on what is defined previously) result in changed traffic flow through variable road signs, interruptions in certain parts of the UTS (e.g. stopping a bus line), automated personalized messages sent through the ESSMA to users in the danger zone to support self-rescue, etc. The consequences of the strategy (e.g. blocked paths) are visualised in the respective monitoring function(s).
Application Scenario	The alarm mode has been started and the operator has decided to apply a resilience strategy (possibly but not necessarily based on what the CRAMMS decision support has proposed).
Interaction Steps	The operator selects a resilience strategy out of several strategies recommended by the DSS. The operator confirms the strategy.
Alternative paths	If in an alarm situation, the operator has not manually confirmed or denied the proposed resilience strategy with the highest resilience index after a defined timeout (e.g. 1 Min.), then the CRAMSS starts the resilience strategy automatically.
Comments	Start a resilience strategy

Name	Adapt the currently active resilience strategy
Description	Once a pre-defined resilience strategy has been started, the operator can still adapt the course of actions by adapting single parameters.
Primary actors	Operator Critical Infrastructure
Preconditions	User logged in; CRAMSS fully functional; alarm mode active;
Result	The response pattern of the resilience strategy is modified in a particular node or other variable.
Application Scenario	A resilience strategy has been started that has automatically blocked 5 passageways. The operator needs to unblock one of them to facilitate the evacuation of passengers.
Interaction Steps	The operator selects the respective element, e.g. a node on the map, and opens its context menu. He selects "unblock" from the context menu and confirms the action.
Alternative paths	None.
Comments	If available, the DSS may advise the operator of possible consequences of the adaptation, e.g. if limits of people per node may be exceeded.

Name	Define a new resilience strategy
Description	In normal operations, the operator defines the resilience strategies that are then available in emergency mode.
Primary actors	Operator Critical Infrastructure
Preconditions	User logged in; CRAMSS fully functional; normal mode active
Result	A new resilience strategy is saved in the database
Application Scenario	The CRAMSS has been installed in a new location. To make it fully functional, the DSS needs input in the shape of resilience strategies, out of which the DSS will propose the best fitting strategy in a certain emergency condition.
Interaction Steps	"The operator opens the widget for defining resilience strategies.

Alternative paths	The system provides a table format with fields for selecting onset conditions and with processes / consequences to be activated under such circumstances.
Comments	The operator saves the new resilience strategy under a specific name and exits the widget / sub-menu."

Name	Edit an existing resilience strategy
Description	In normal operations, the operator adapts an existing the resilience strategy that are then available in emergency mode.
Primary actors	Operator Critical Infrastructure
Preconditions	User logged in; CRAMSS fully functional; normal mode active; a resilience strategy is available (previously defined or imported).
Result	The resilience strategy is altered and saved under the same name.
Application Scenario	A risk map for flooding has, been provided and a certain resilience strategy needs to be altered to take the new requirements into account.
Interaction Steps	The operator opens the menu / widget for defining or altering resilience strategies. He/she selects an existing strategy from the list and clicks "edit". New onset conditions or processes are defined by selecting from given options. The result is saved.
Alternative paths	None.
Comments	Possibly, it would be nice to have a feature for copying an existing strategy and then altering it and saving it under a new name (reduce workload). A cancel / abort and abolish changes feature is very important.

Name	Delete a resilience strategy
Description	Once, a resilience strategy is outdated and no longer needed, it needs to be deleted.
Primary actors	Operator Critical Infrastructure
Preconditions	User logged in; CRAMSS fully functional; normal mode active; a resilience strategy is available (previously defined or imported).
Result	The resilience strategy is removed from the database.
Application Scenario	The operator wants to delete a no longer required resilience strategy.
Interaction Steps	The operator opens the menu / widget for defining or altering resilience strategies. He/she selects an existing strategy from the list and clicks "delete". He/she confirms the deletion in the security check that pops up.
Alternative paths	None.
Comments	Delete a resilience strategy

Name	Upload training contents for the GBTA
Description	Unless the GBTA will get its own management application, the CRAMSS and its user will be in charge of updating training contents when necesssary.
Primary actors	Operator Critical Infrastructure
Preconditions	Training contents available as a data file. Conditions of which users will have access to this training (e.g. only after completing another more basic training) have been agreed upon by the persons in charge of managing the training. User is logged in and the CRAMSS is functional.
Result	New training content is available in the GBTA to the respective users, only.
Application Scenario	A new training has been developed and is to be made available to the users.

Interaction Steps	1. The user selects the upload feature 2. The user selects the availability criteria from a given list of options (restrictions to user role [passive; informal active; formal active] and previously completed training [list all currently available trainings]). 3. The user selects the file of the training data file from a file-explorer feature and uploads it.
Alternative paths	-
Comments	-

7.2 Development of the ESSMA

The following Use Cases were created to start the development of the application.

Name	Create user profile
Description	The user creates a personal profile in order to receive personalised guidance.
Primary actors	End user (civilian, rescue personnel)
Preconditions	ESSMA installed on the mobile device.
Result	The user profile of the respective user is saved locally in the app and centrally in the respective RESOLUTE data storage.
Application Scenario	For the personalised evacuation guidance, the system needs to take mobility parameters of the users into account. Therefore, a feature is needed to introduce such parameters. Additionally, the system may ask the user to provide user data from social media (facebook, twitter, etc.) to increase the efficiency of the RESOLUTE system. This should be linked to the profile editing.
Interaction Steps	1. The user opens the profile setup. It should automatically open at the app's first start and can be found later to change the parameters if necessary. 2. The user logs into social media via the app, providing relevant user data for RESOLUTE background functions. This requires accepting the RESOLUTE privacy agreement. 3. The user introduces his data in the given entry fields. Examples: Selecting one out of several mobility categories [blind, wheelchair, walking sticks, no impairment]; introducing the age in years. "
Alternative paths	None.
Comments	-

Name	Start self-rescue
Description	The personalised emergency guidance is started and executed. The way it looks depends on the approach chosen (see D5.1 for all options).
Primary actors	End user (civilian, rescue personnel)
Preconditions	ESSMA installed on the mobile device, emergency situation detected (near the user), CRAMSS fully functional. Optional: user profile data available.
Result	The self-rescue route guidance is started and executed until the user reaches the destination (safety spot / exit) or until the user aborts the route guidance.
Application Scenario	If an emergency is detected near the user, the CRAMSS will automatically provide personalised route guidance to the users in order to get them to safety with maximum efficency.
Interaction Steps	1. The user is alerted / advised to proceed to the exit by a pop-up message on the mobile device. 2. The user opens the ESSMA app 3. The user starts the guidance. 4. The guidance is either aborted or successfully terminated.

	5. The ESSMA guidance is no longer available. "
Alternative paths	None.
Comments	-

Name	Add peers to the (added-value) "locate peers" feature
Description	The added value feature is meant to help people locate other important persons. This is not only useful as an incentive for people to install the ESSMA, it is also assumed to increase self-rescue efficiency: if people know their peers are in a safe place, they will evacuate instead of possibly going looking for them in a dangerous place.
Primary actors	Civilians (passive role).
Preconditions	ESSMA installed on the mobile device of "user" and "peer".
Result	The ESSMA can display the location of the peer (on demand).
Application Scenario	The user want to add a person, such as a relative, to his peers list, in order to be able to locate him/her during an emergency situation.
Interaction Steps	1. The "user" opens the "locate my peers" feature. 2. The "user"" adds the "peer", e.g. by selecting from the address book, inserting the telephone number, or else. 3. The "peer" gets a notification in his/her own ESSMA. 4. He/she confirms the request. Then, the ""peer"" is visible for the "user" 5. [or, instead of 4.] He/she denies the request. Then, the "peer" is NOT visible for the "user"
Alternative paths	At a later stage, this may be integrated with, e.g., the "safe" marking feature in facebook.
Comments	-

Name	Upload contents
Description	Fotos or videos are uploaded by users (passive or active) to help authorities get a picture of the situation.
Primary actors	Rescue personnel (informal and formal active role)
Preconditions	ESSMA installed, integrated camera functional.
Result	A foto or video is uploaded and available to CRAMSS users and other users of the ESSMA.
Application Scenario	The ESSMA provides, in connection with social media, the option to upload fotos and videos. Sending these data through the ESSMA may give authorities a quicker overview what is going on than on other platforms. It also incentivates the users to connect their social media accounts, which is helpful for user analysis in order to improve predictions and resilience management.
Interaction Steps	1. The user takes a photo / picture. 2. The user opens the ESSMA and selects the "upload" feature. A list of uploaded contents is shown, together with an "add" button. 3. Activating "add" opens the link to the gallery. The file is selected and confirmed. 4. Upload starts (possibly after conversion, e.g. for bandwidth reasons). Progress is displayed. 5. The UI goes back to the list after the upload has finished.
Alternative paths	The user could also open the camera from the upload feature and then confirm the upload once the foto / video has been recorded.
Comments	In terroristic attacks, authorities usually restrict social media communication on the events, in order to ensure that terrorists will not profit from such data. The ESSMA could thus possibly restrict the access to such contents to formal active users and CRAMSS (/resilience dashboard) users.

Name	Start rescue-navigation
Description	This use case represents the currently not in detail defined functions for active role users.
Primary actors	Rescue personnel (informal and formal active role)
Preconditions	ESSMA installed, user characterised as "active" (possibly with more personal details on clearance level).
Result	The user is guided to a position where he should act in order to fulfil a resilience function in the UTS.
Application Scenario	The CRAMSS may either in emergency condition or standard operations, be used to advise certain users with formal roles (civil protection, police, station personnel) about important aspects of operations, such as the position of people in need of help. A route guidance to such a position is available if the user requests it.
Interaction Steps	1. A map and/or list of events in the ""active"" user's ESSMA shows what may be relevant processes or targets for the user (possibly defined based on criteria). 2. The user selects one of the events / positions. A context menu is opened. 3. The user selects the option ""go there"" (or similar). 4. A route-guidance to this position is started. 5. The route-guidance ends once the user has reached the destination or aborts the guidance manually.
Alternative paths	In many cases, ground staff may rather use the app for getting a quick overview and receive orders through the standard hierarchy from their superiors. This function is rather to support than to replace such traditional paths.
Comments	-

7.3 Development of the GBTA

The following Use Cases were created to start the development of the application.

Name	Create user profile
Description	(In case the ESSMA has not yet been installed)
Primary actors	End user (civilian, rescue personnel)
Preconditions	GTBA installed
Result	The user profile is created so the GBTA can be used; the profile can later be imported into the ESSMA.
Application Scenario	The user has installed the GBTA but not the ESSMA. The user wants to use the GBTA without achievements being lost (or not taken into account) once the ESSMA is installed later.
Interaction Steps	1. The user opens the profile setup. It should automatically open at the app's first start and can be found later to change the parameters if necessary. 2. The user logs into social media via the app, providing relevant user data for RESOLUTE background functions. This requires accepting the RESOLUTE privacy agreement. 3. The user introduces his data in the given entry fields. Examples: Selecting one out of several mobility categories [blind, wheelchair, walking sticks, no impairment]; introducing the age in years.
Alternative paths	The profile is automatically imported from the ESSMA.
Comments	-

Name	Start training

Description	The main functionality of this app is executing the trainings.
Primary actors	End user (civilian, rescue personnel)
Preconditions	GBTA installed.
Result	Training is executed.
Application Scenario	Trainings can be quizzes or other interactive games. The user wants to pass time in a fun way and/or learn something relevant, which is why the app is being used.
Interaction Steps	1. The user opens the list of trainings. 2. The user selects a training. 3. The user selects "start". 4. The training ends on whatever is defined in the specific training (timeout, when clicking ""next"" on the last page, etc.).
Alternative paths	None.
Comments	-

Name	View / share achievements
Description	To increase user motivation, the GBTA gives feedback on achievements.
Primary actors	End user (civilian, rescue personnel).
Preconditions	GBTA installed.
Result	A list of the achievements is displayed.
Application Scenario	The user wants to check achievements or share achievements on social media.
Interaction Steps	1. The user selects "achievements". 2. The list of achievements is displayed. 3. The user selects an achievement and then "share". He/she selects the social media in which to publish the achievement.
Alternative paths	None.
Comments	-