

Resilience management guidelines and Operationalisation applied to Urban Transport Environment

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Generating system adaptive capacities through data and information access
The RESOLUTE guidelines



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RESOLUTE adopts a **resilience engineering** perspective, according to which adaptive capacities are considered a fundamental resource to cope with high operational variability and uncertainty (known and unknown changes in operational environment of CI)

The intrinsic ability of a system to adjust its functioning prior to, during or following changes and disturbances, so that it can sustain required operations under both expected and unexpected conditions (Hollnagel, 2011)

4 system adaptive capacities
must be developed

- **Knowing what to do** corresponds to the ability to address the “actual” and respond to regular or irregular disruptions by adjusting function to existing conditions.
- **Knowing what to look for** corresponds to the ability to address the “critical” by monitoring both the system and the environment for what could become a threat in the immediate time frame.
- **Knowing what to expect** corresponds to the ability to address the “potential” longer term threats, anticipate opportunities for changes in the system and identify sources of disruption and pressure and their consequences for system operations.
- **Knowing what has happened** corresponds to the ability to address the “factual” by learning from experiences of both successes and failures.

1. The RESOLUTE approach

Methodology

Functional modelling of critical infrastructure

(FRAM-Functional Resonance Analysis Method)



Guidelines (ERMG) for the enhancement of CI functions

Each guideline was derived from a function in the model

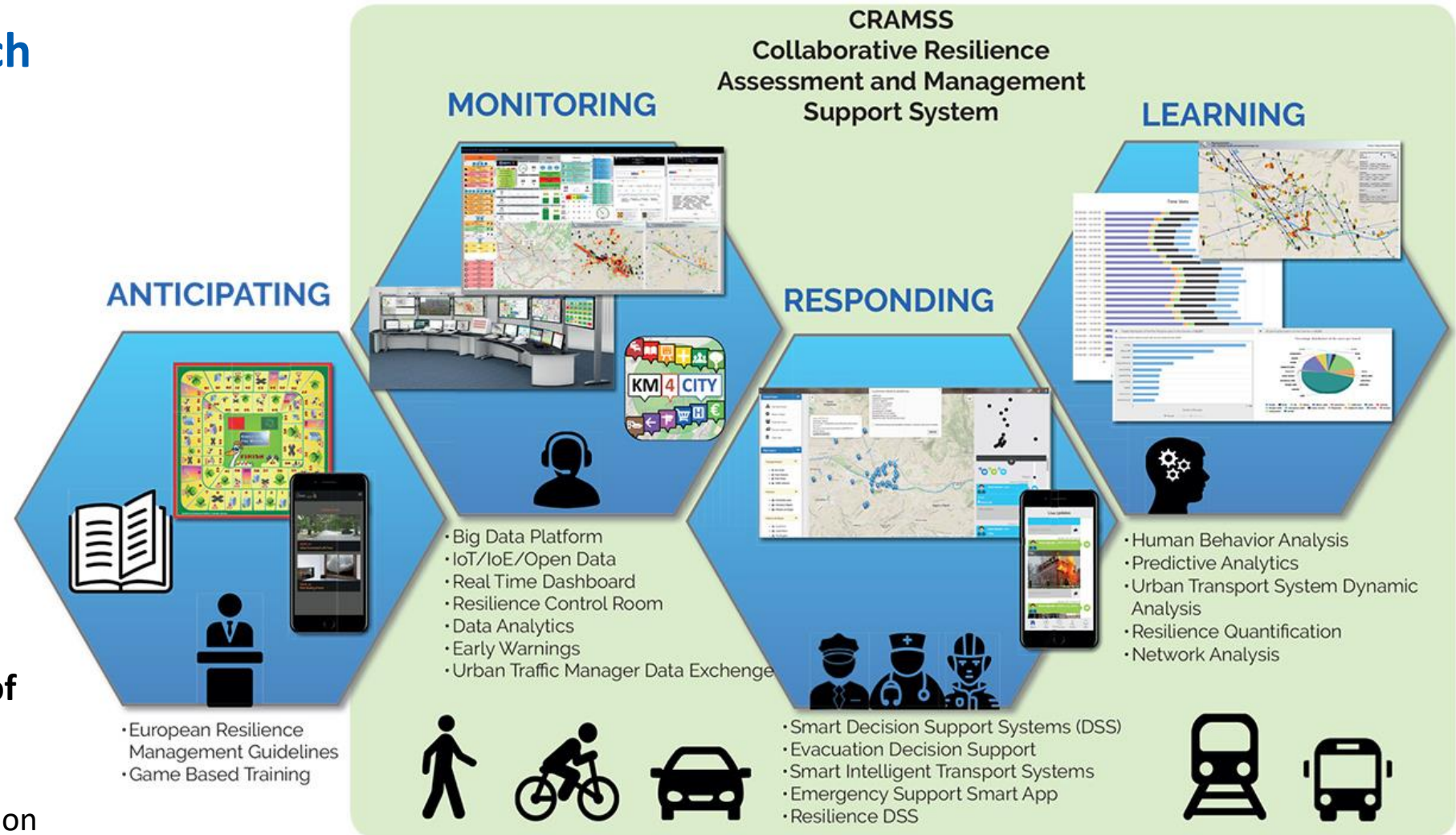


Tools for the operationalisation of the ERMG

CRAMSS platform that integrates multiple stakeholder inputs and decision support tools



Enhanced cooperation and coordination between UTS stakeholders



2. FRAM modelling

Functions relating to
“Knowing what to expect”
(Anticipation capacities)

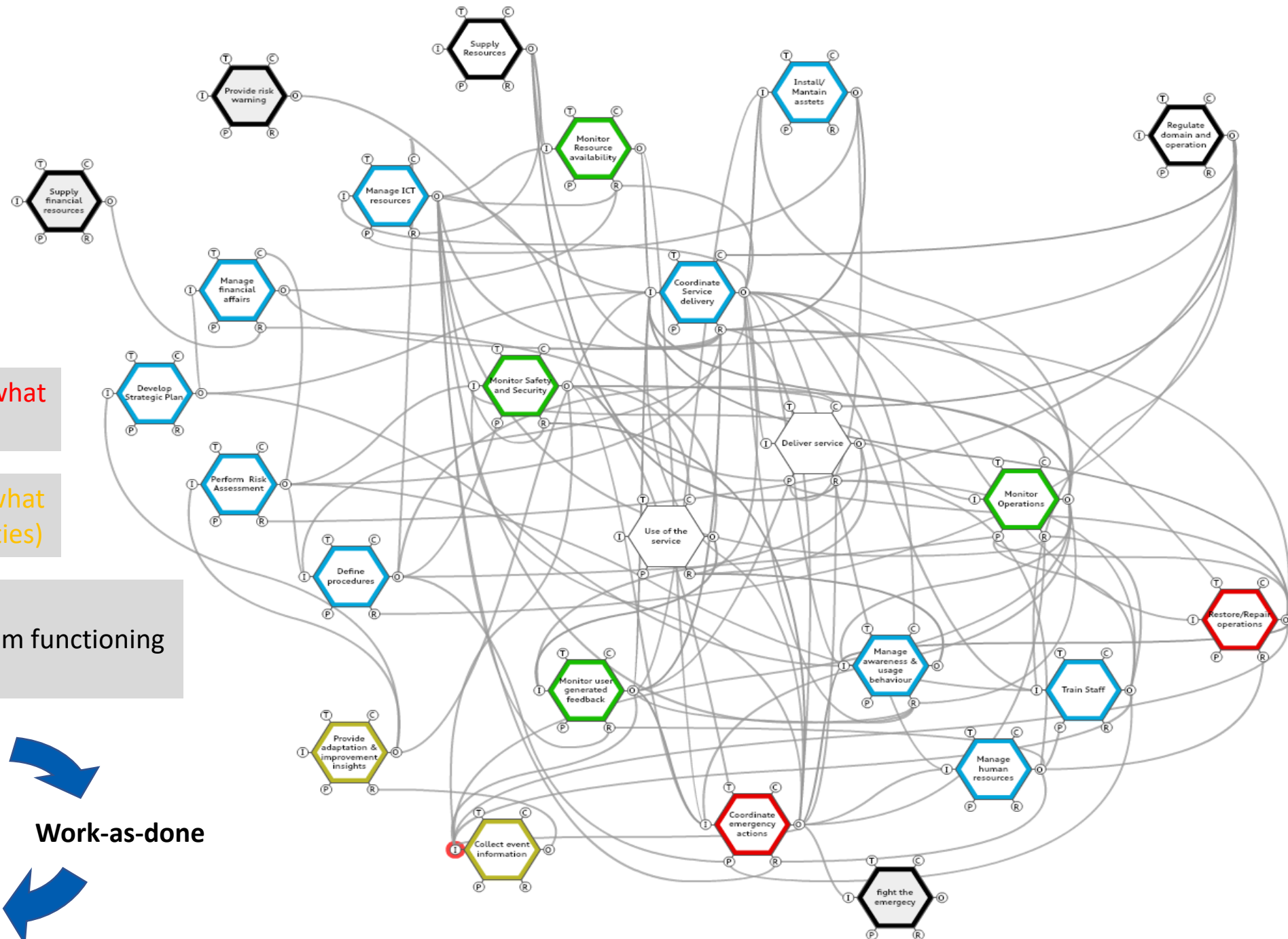
Functions relating to
“Knowing what to look for”
(Monitoring capacities)

Functions relating to “Knowing what
to do” (Response capacities)

Functions relating to “Knowing what
has happened” (Learning capacities)

Background functions

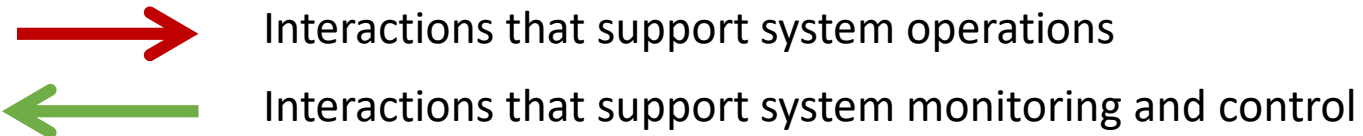
- Provide relevant inputs to system functioning
- Indicate system boundaries



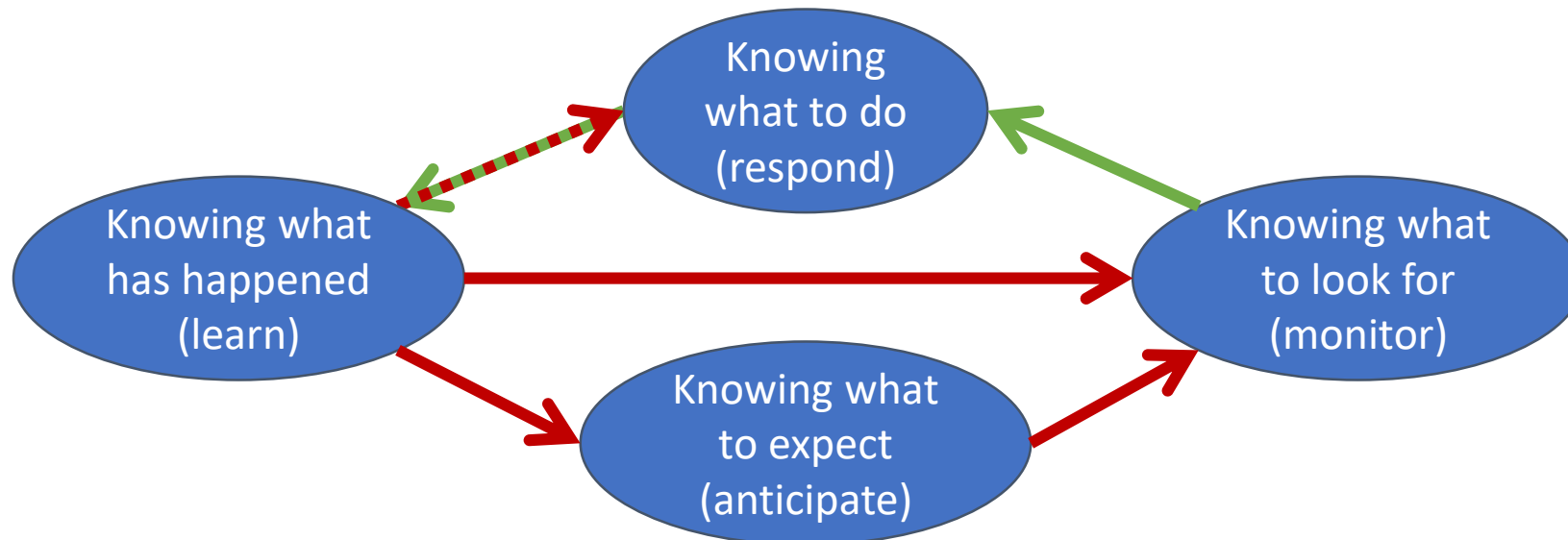
3. The RESOLUTE guidelines

The 4 resilience cornerstones and the ERMG

System functions (structures, mechanisms, devices...) must be architected and managed in such a way that interdependencies generated within and beyond system boundaries are capable of sustaining these 4 cornerstones



Like system operations, the 4 cornerstones are themselves interdependent which means that they none can be sustained without the remaining ones, even if at some stage, area or scenario, some may become more relevant than the remaining



3. The RESOLUTE guidelines

Guideline structure

- Abstract (introduction of scope)
- Background facts (rational and relevancy)
- General recommendations
- Common performance conditions (context related aspects)
- Interdependencies (coupled functions)
- Limitations
- Questions (Support for guideline implementation)
- Examples
- Sources (literature and additional information)

Guidelines for each of the 4
resilience capacities

Knowing what to expect (anticipate)

- Develop Strategic Plan
- Manage financial affairs
- Perform Risk Assessment
- Training staff
- Coordinate Service delivery
- Manage awareness & user behaviour
- Develop/update procedure
- Manage human resources
- Manage ICT resources
- Maintain physical/cyber infrastructure

Knowing what to look for (monitor)

- Monitor Safety and Security
- Monitor Operations
- Monitor Resource availability
- Monitor user generated feedback

Knowing what to do (respond)

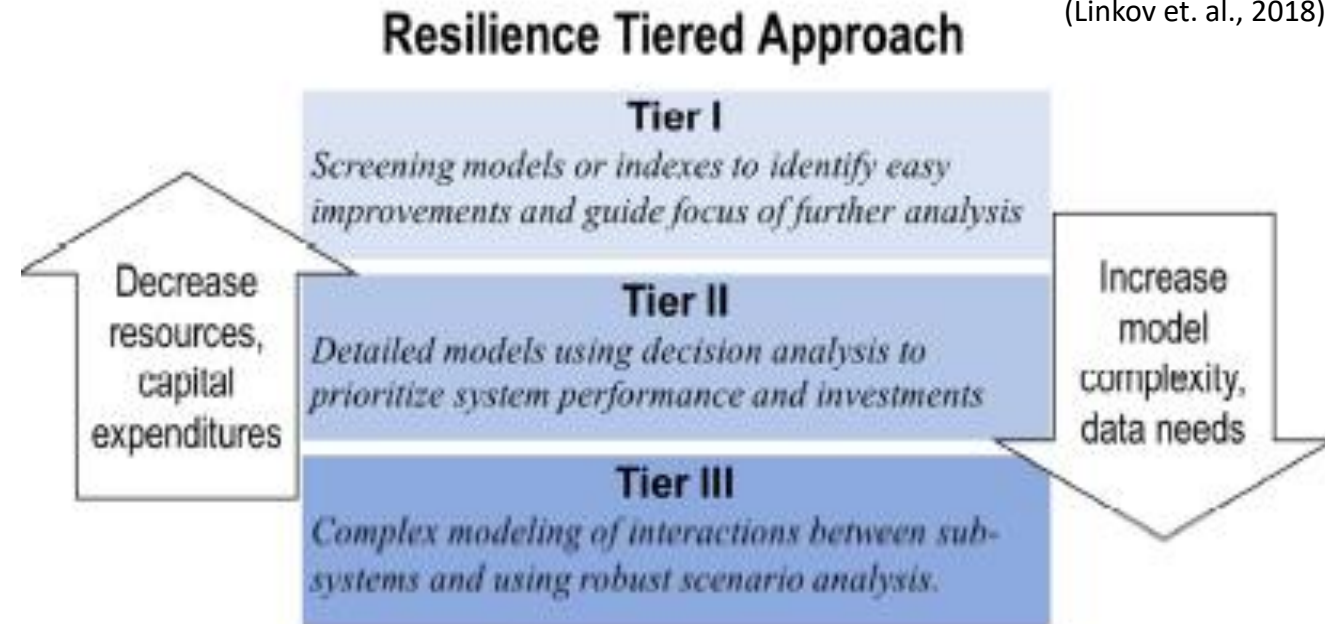
- Coordinate emergency actions
- Restore/Repair operations

Knowing what has happened (learn)

- Collect event information
- Provide adaptation & improvement insights

3. The RESOLUTE guidelines

- Support a self-assessment and multilevel gap analysis in respect to the potential for resilience of CIs
- Structured to support the reader in the assessment as well as improvement of the CI
- The focus is placed on the CI as an interdependent sociotechnical system and in that sense, the ERMG should be applied adopting a complex view and under a coordinated strategy between CI stakeholders



Level I: Analysis can be carried out by the comparison between the “desired functions” defined in ERMG against the functions and interdependencies identified through a FRAM analysis of the CI under assessment. The absence of one or more functions immediately orients decision makers towards its implementation as applicable. The ERMG provides also a number of desired interdependencies that contribute to an enhanced potential for system resilience.


Level II: Based on the assessment of how the FRAM functions and the interdependencies implemented in the assessed CI are actually aligned with the ERMG recommendations. The reader should be able to understand if general as well as common conditions and recommendations are applied and to which level of maturity. Indications and insights on how to improve capabilities to manage the variability of functions’ output can be retrieved from the document.

Level III: Requires a resilience quantification exploiting data generated within the system (e.g. Smart City) in order to better detail existing gaps. Functions performance and variability need to be quantified using real data aggregated through KPIs and methods to compose synthetic indicators.

3. The RESOLUTE guidelines

Initial steps towards adopting the ERMG should ensure that critical functions and interdependencies are sufficiently known and described. Special attention should be devoted to:

- Other teams and departments that supply important information or other types of resources to the team or department in question
- Other teams and departments that rely on information or other types of resources produced by the team or department in question
- Other teams and departments that carry out or have ownership of any operational oversight or control (i.e. quality or performance monitoring and assessment, safety compliance, among others) over the team or department in question
- Other teams and departments over which the team or department in question carries out or has ownership of any operational oversight or control (i.e. quality or performance monitoring and assessment, safety compliance, among others)



6.1.3 Perform Risk Assessment

Anticipate	Monitor	Respond	Learn
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General Recommendations

- The Integrated Assessment of different risk natures, i.e. safety, security, environment, economic and business continuity, among others.
- Need for periodic update of risk models in view of operation and context changes.
- Increased need for integrated risk assessment in order to ease coordinated risk management actions and measures.
- Shifting from single "all purpose" tools to a set of integrated tools that respond to different risk assessment needs and that are able to exploit heterogeneous data generated within and outside the system.
- Adopting tools that provide the ability to continuously update risk assessment needs in view of changes in safety models.
- Prospective and anticipation needs through the assessment of potential impacts of both known and unknown changes in operations and their environment.

Common Conditions Recommendations

Availability of resources	Need for measurement or detection equipment; sufficiently precise assessment methods may be used. Human Skills & competence; Budget; Data & Algorithm
Training & experience	Subject matter experts should be consulted in order to validate hazard identification; Local staff involvement is critical for hazard identification and for insight on risk perceptions and operational processes.
Quality of communication	Ensure the accuracy of data and risk assessment outcome communication to all interested actors in the organization avoiding allegations & manipulations.
HCI & Operational Support	IT systems are increasingly important for the effective reporting of hazards & risks, and the support of decision-making, for instance when reviewing safety cases.
Availability of procedures & plans	Risk Assessment activities must be integrated in business & organizational process description, as opposed to independent or "stand-alone" activities; Operation & process change control processes must call on risk assessment & determine when they are required.
Conditions of work	A suitable level of independency & autonomy should be formally ensured to risk assessment teams.
Number of goals & conflict resolution	Adopt tools responding to assessment needs of different process stages: planning, operation, maintenance, decommissioning; Precision (quantitative & qualitative) of risk assessment to match process stage requirements & objectives.
Available time & time pressure	Time pressure should not compromise thoroughness & validity of risk reporting.
Circadian rhythm & stress	Monitoring and assessing human factors under shift work or roster conditions tends to be more complex. Monitoring and assessment conditions are much more dynamic and diverse.
Team collaboration quality	Team work may be relevant when assessing more complex operations & when producing risk reports; Necessary to establish a collaborative environment among sectors & departments & the risk assessment team.
Quality & support of the organization	Senior management, should officially endorse evaluators; Organisational support as fundamental contribution for the risk assessment activities and their outcome; Interaction w/ stakeholders may require some formal organisational setting.

Interdependencies Recommendations

Hindsight on events requires reliable relations both within the organisation and often amongst stakeholders. Beyond the description of linear relations of causality, this should support the identification of interdependencies and their impacts in terms of performance variability, which requires more than conventional accident and incident investigations.

Abstract

Risk assessment (RA) is inherently related to an estimation of uncertainty at different levels. In addition to minimising uncertainty, RA must also take into account:

- the estimation of types & levels of resources that may be required to adapt to unexpected events;
- the need for update in view of emerging factors or perceived operational changes.

Background

RA serves the purpose of supporting:

- the definition of priorities for action;
- the determination of its nature & course.

As resources are always finite, the potential need for additional resources must be considered and aligned with actual potential operational needs at different levels.

Example

- Risk fore with teams involved in managing different risk domains, addressing potential needs to review risk models & assessment tools.
- Team reviews of RA, focusing mainly on the risk interpretation factors & their mapping onto real operational context & specific scenarios.

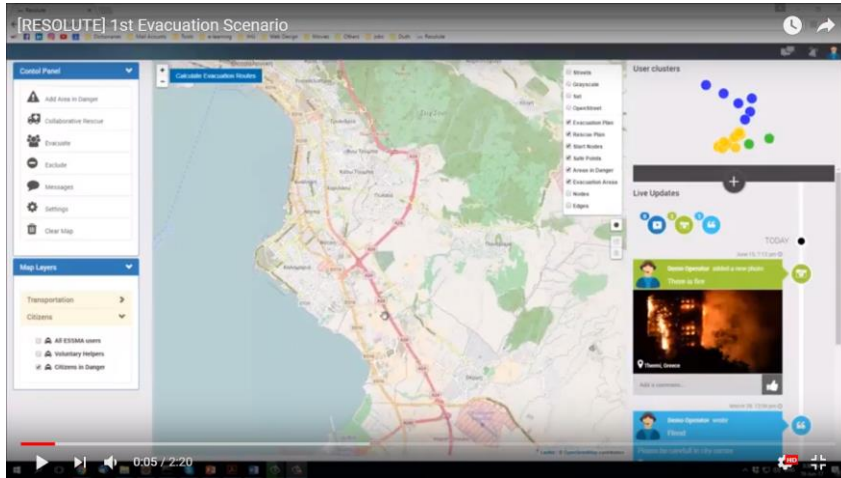
Limitations

Applicability, reliability, accuracy and validity of assessment tools and means to test them regularly as operations change.

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4. Operationalisation of ERMG

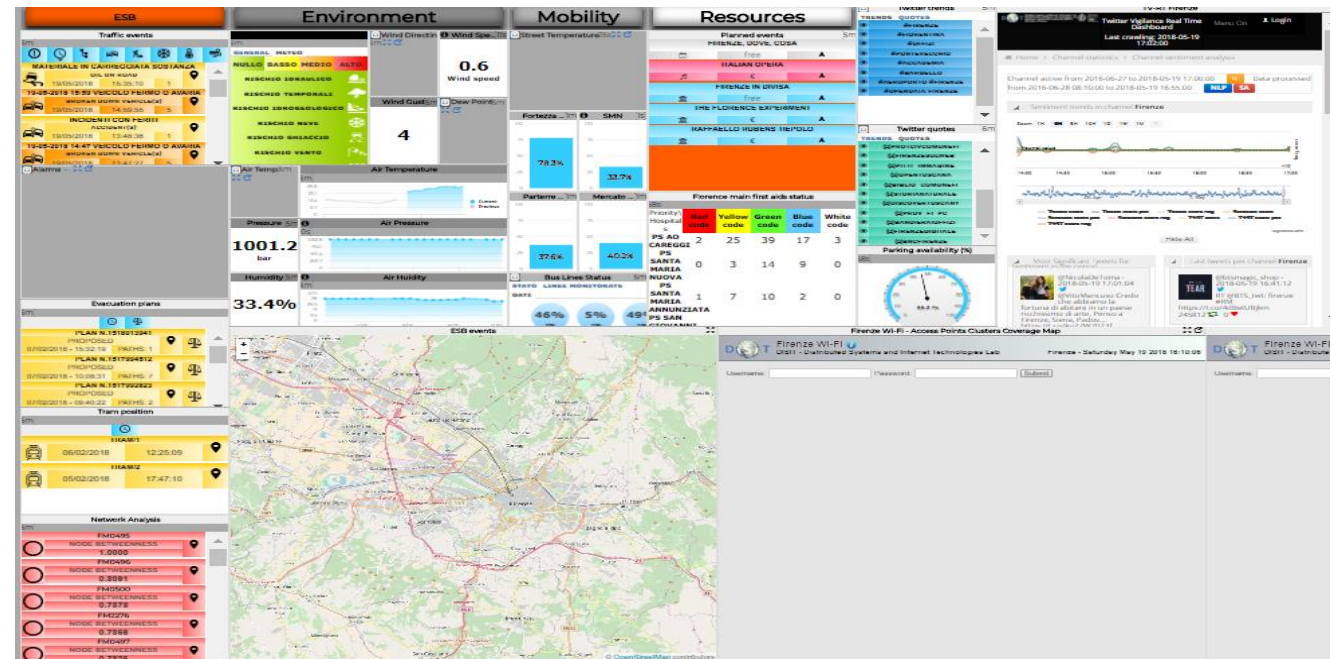
- Improved information and data flows across CI operational interdependencies
- Providing stakeholders with enhanced capabilities for “push” and “pull” of information
- Context related criteria for automated information and data processing (time and space relevancy)

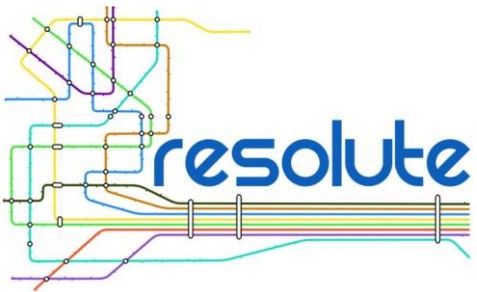


The Emergency Support Smart Mobile App (ESSMA) aims to assist the resilience of a community keeping civilians updated and guided for their reactions under emergency situations. The main objective of the ESSMA application is to give the opportunity to civilians to be aware of emergencies and to know the most appropriate way to reach a position of safety.

The Resilience Dashboard represents the synthesis of the status of the Urban Transport System (UTS) and it is thought for being installed in each control room of the interested stakeholders. The Dashboard has been designed to be used by different users such as Civil protection, Mobility dept., Urban Police...

<http://dashboard.km4city.org/dashboardSmartCity/view/index.php?iddashboard=MTI5>





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