Resilience management guidelines and Operationalization applied to Urban Transport Environment

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Problem and issues

- Critical infrastructures in the city are strongly interdependent:
  Transport, energy, communication, cyber, health...

- Critical Infrastructure are hit by natural and/or human made expected and unexpected events.

- UTS, Urban Transport System, is one of the most challenging since UTS is the via by which effects may be propagate but also the path used by solutions and the recovery actions.
Main criticalities in a (smart) City

- **Over-specification** of procedures
- **Multi-decision-makers** (civil protection, public administration, infrastructure managers, etc.),
- UTS users (citizens) with their **conflicting micro-opportunistic behaviors**, different risk perceptions, beliefs, skills, etc.
- **Heterogeneous data sources** with different data delivery rate, quality, reliability and semantics.
- **Fragmented** and sometimes not clearly defined **responsibilities** among UTS actors.
- Needs to optimally manage the **scarcity of resources**
- Needs of a coordinate **multi-channel communication** strategy and a situation-aware communication delivery tools
- Common attitude of the authorities to neglect the preparing and adapting **phases** in favor of the absorbing and reacting phases.
- Weak population preparedness against unusual extreme events and wrong perception about their recurrence probability and potential effects.
Project main Outcomes

- **European Resilience Management Guidelines** – (guidelines) – consensus driven approach improve guidelines acceptability at EU level
  - general version, and UTS version
- **CRAMSS** – (tools and algorithms) – ontology based static and dynamic CI data integration, processing and analysing platform
- **Mobile Emergency app** – (tools and procedures) – supporting users in their local decision before (early warnings), during and after an event
- **Game based training app** – (tools and procedures) – improving the current preparedness of the citizen in order to increase the community self-resilience
Resilience is the **ability** to prepare and plan for, absorb, recover from, and more successfully adapt to adverse event [NAS]
Resilience as adaptive capacity

Adaptive capacity:

1) **Knowing what to do** -> ability to address the “actual” and respond to regular or irregular disruptions by adjusting function to existing conditions.

2) **Knowing what to look for** -> ability to address the “critical” by monitoring both the system and the Environment

3) **Knowing what to expect** -> ability to address the “potential” longer term threats, anticipate opportunities for changes in the system

4) **Knowing what has happened** -> ability to address the “factual” by learning from experiences of both successes and failures
Towards Smart Panarchic City

Developing and mobilizing Urban adaptive capacities into a multi-scale time framed cycle

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From Risk to Resilience

1) Enforcing Stability -> Accept/dump variability
2) Resist -> Adapt
3) Expect knowns -> Expect unknowns
4) Breakdown at boundaries -> Tolerance, graceful degradation
5) Centralization -> Decentralization, local knowledge
6) Central C&C -> Directed opportunism (mission command)
7) Reducing local DoFreedom -> Increasing local DoF (margin of maneuver)
8) Compliance to roles -> Problem solving, flexibility
9) Minimising uncertainty -> Cope with uncertainty
10) Bounce back -> Bounce forward (better)

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ERMG Operationalization: Big KID (Knowledge, Information, Data) Approach

Connecting (Big) Data to the model

Descriptive

Decision Support System for Decision Makers and CI managers

- Data driven Resilience Assessment
- Prediction-simulation
- Real time emergency management
- (trade off costs-time to recovery)
- Training and preparedness assessment
- ….

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Resilience objective in RESOLUTE

**PREPARE/PLAN:**
ERMG risk map, vulnerability analysis, predictive analytics, Resource availability and allocation monitoring, Game-based training

**ABSORB:**
Dashboard RT, situational awareness, event dynamic tracking, real time operational decision support, Evacuation app

**RECOVERY:**
Real time damage and function degradation estimation, resource availability and demand monitoring and estimation

**LEARN:**
Big Data storage of events, actions, sensors, etc., Big Data mining and intelligence

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IEEE ISC2 Smart City Trento, 2016
FRAM-based UTS modeling

Functional Variability

Variability propagation through function interdependency

Possible functional Resonance (failing in damping variability)
UTS and Big Data

Huge amount of data are produced from: Open Data, Linked Data, Real Time sensors, Twitter, WiFi, etc.
(Big Data: velocity, variety, volume, veracity, ...)

Data available and collected through km4cty platform
http://www.disit.org/km4city

• Traffic data flows
• Public mobility services real time positions (e.g. bus, metro)
• Open Data (close to 1K available datasets including
  • Hidrogeological risk maps)
• City free Wifi covers the 80% of the city (tracking people flows and movement)
• Social networks (twitters)
• IoT (real time data from environmental sensors e.g. level of the river)
• Real time Parking availability
• City services (business,
• Real time status of the city hospitals-beds availability
• Meteo data
• Cadastre data
• ....but more data are needed.

ISSUES
Multiple data owners-producers,
Different delivery rate,
Different formats,
Different data quality,
Different licence for data reuse, etc…
RESOLUTE platform

Monitor + Learn

Operationalization

ERMG

Respond

Anticipate + Monitor

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Collaborative Resilience Assessment and Management Support System

RESOLUTE Dashboard

ESB

UTS-DSS

Evac.DSS

Other DSS

Informed decisions
On mobility

Sent evacuation to ESSMA

Decisions

Informed decisions for Operators,…

Cross-institution Collaboration through info sharing

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Florence Pilots – empower public awareness

A game to disseminate resilience mindset and good practices.

More then 200 kids has been “trained” at school.
Impact

• Demonstrate capacity of timing intervention and operator’s synchronization defragmenting information sources
• Timely and thorough response.
• Effective information propagation through multiple communication channels (mobile app, city panels, radio, etc.)
• Fast restoration of pre-emergency traffic and UTS conditions.
• A stronger perception of the risk and within the community