ERMG ADAPTATION TO UTS

Project Title	RESOLUTE
Project number	653460
Deliverable number	D3.8
Version	0.1
State	FINAL
Confidentially Level	CO
WP contributing to the Deliverable	3
Contractual Date of Delivery	M36 (30/04/2018)
Finally approved by coordinator	30/04/2018
Actual Date of Delivery	2/05/2018
Authors	Evangelia Gaitanidou (CERTH), Emanuele Bellini (UNIFI), Pedro Ferreira (COFAC)
Email	lgait@certh.gr
Affiliation	CERTH
Contributors	L. Coconea (SWARCO), A. Deloukas, E. Apostolopoulou (Attiko Metro), S. Cigheri (THALES), A. Candelieri (CMR), A. Zamichos, I. Symeonidis, A. Spiliotis, M. Panou, E. Bekiaris (CERTH), L. Mendoza (HUMANIST), E. Bellini (UNIFI)

funded by the Horizon 2020
Framework Programme of the European Union

WWW: www.resolute-eu.org
Email: infores@resolute-eu.org

EXECUTIVE SUMMARY

This document, entitled D3.7 ERMG Adaptation to UTS, provides an updated version of Deliverable D3.7, issued in 2016. The UTS ERMG, as presented in the latter document, has been updated in the present Deliverable, following the findings of the project pilots, as well as the guidance of the RESOLUTE Advisory Board. Keeping the original rationale and structure, a full, updated version of the guidelines has been produced, followed by a short version, limited to 1 page per function, providing the main recommendations and highlighting the most important aspects.

The document is structured in five Chapters and one Annex. More specifically:

- Chapter 1 is the Introduction where the scope and objectives of the document are presented

- Chapter 2 is the Methodology. In this chapter it is described how the UTS ERMG has been updated, taking into account the results of the RESOLUTE pilots as well as the comments of the Advisory Board. The updated and short versions that follow, are also introduced.

- Chapter 3 includes detailed instructions of how to use the UTS ERMG in practice, along with a relevant example.

- In Chapter 4, the updated version of the UTS ERMG is included in detail, following a similar structure as in the D3.5, with updated contents, following the recommendations coming from the pilots and the Advisory Board.

- In Chapter 5 conclusions are drawn regarding the contents and use of the UTS ERMG

- Finally, in Annex A, the short version of the UTS ERMG is presented, highlighting the most important recommendations in a 1-page-per-function format.

PROJECT CONTEXT

Workpackage	WP3: European Resilience Management Guidelinees
Task	T3.4: ERMG Adaptation to UTS
Dependencies	WP2, WP6

Contributors and Reviewers

Contributors	Reviewers
L. Coconea (SWARCO)	E. Bellini (UNIFI)
A. Deloukas, E. Apostolopoulou (Attiko Metro)	
S. Cigheri (THALES)	
A. Candelieri (CMR)	
A. Zamichos, I. Symeonidis, A. Spiliotis, M. Panou, E. Bekiaris (CERTH)	

L. Mendoza (HUMANIST)	
E. Bellini (UNIFI)	

Version History

Version	Date	Authors	Sections Affected
V01	3/4/2018	Evangelia Gaitanidou	All
V02	15/4/2018	All authors and contributors	Chapter 4, Annex A
V03	25/4/2018	All authors and contributors	All
V04	30/4/2018	All authors and contributors	All

Copyright Statement – Restricted Content

Table of Content

List of Figures

List of Tables

1 INTRODUCTION

Enhancing resilience in Urban Transport Systems, UTS, is considered imperative for two main reasons. First of all, such systems provide critical support to every socio-economic activity and are currently themselves one of the most important economic sectors in Europe. Secondly the paths that convey people, goods and information, are the same through which risks are propagated. Transport systems have thus developed a prominent safety and business critical nature, in view of which current management practices have shown evidence of important limitations. In essence, the majority of management practices are based on the assumption that systems and their operations can be fully understood and described and, therefore, a level of operational control deemed appropriate can be perceived, achieved and maintained, mainly by resorting to linear (purely based on cause-effect relations) and probabilistic risk assessment approaches. This does not take into account the underspecified nature of complex sociotechnical systems and the need to cope with fast pace changing environments.

Resilience design and management for UTS is nowadays a necessity, in order to effectively confront the difficulties arising from UTS system complexity and exposure to threats (see more in D3.7). The general principles that should be followed could be summarized in the following:

- Prevent incidents within control and responsibility, effectively protect critical assets.
- Respond decisively to events that cannot be prevented, mitigate loss and protect employees, passengers and emergency respondents.
- Support response to events that impact local communities, integrating equipment and capabilities seamlessly into the total effort.
- Recover from major events, taking full advantage of available resources and programs.

These issues are tackled in detail in the ERMG (D3.5 and updated version in D3.6), presented upon adaptation for the UTS in Chapter 4 of the present Deliverable.

1.1 Scope

RESOLUTE is based on the vision of achieving higher sustainability of operations in European UTS. The project recognises foremost the ongoing profound transformation of urban environments in view of ecological, human and overall safety and security needs, as well as the growing importance of mobility within every human activity. Sustainability is rapidly becoming an imperative need across all economic and social domains. Among many things, this requires overall enhanced operational efficiency, mainly by optimising the allocation and utilisation of available resources (organisational technical and human), whilst striving to continuously minimise any source of waste, namely incidents, accidents and other operational failures. Within this context, RESOLUTE considers resilience as a useful management paradigm, within which adaptability capacities are considered paramount. Rather than targeting continuous economic and financial growth of businesses and market shares, organisations should develop the ability to continuously adjust to ever-changing operational environments.

Within this framework, the main scope of this Deliverable is to update the UTS ERMG, as originally presented in D3.7, following the findings of the RESOLUTE pilots, the comments from the Advisory Board as well as the updated generic ERMG (D3.6).

The work developed under WP3 is grounded on the RESOLUTE approach to resilience, as outlined in Deliverable D2.1, and was developed in order to match the framework given in Deliverable D2.2. The ERMG are structured in accordance to the four adaptive capacities that complex sociotechnical systems (CSS) should develop to enhance their sustained adaptability. This means that, on the one hand, each guideline individually addresses specific requirements, namely the management and allocation of resources needed. On the other hand, each of the four sets of guidelines aims to produce an integrated, yet flexible operational response to achieve the capacity to which they are assigned.

Each of the guidelines also reflects a specific function identified as operationally critical by means of the FRAM model previously developed (D3.5, D3.7). Based on the functional couplings identified, each guideline aims to reproduce fundamental needs for coordination between functions, namely through the development of critical operational flows of information.

The features herein described supported the development of guidance principles towards resilience that significantly innovate current state of the art. Rather than prescribing solutions towards improved protection, mitigation and recovery, in the face of known threats, RESOLUTE ERMG aim to enhance resource planning and allocation, communication and overall system cooperation and coordination, in order to maintain a flexible yet structured proactive response to continuous change. This is in line with project objectives and the innovative approach to resilience that RESOLUTE aims to deliver for the management of critical infrastructures, in particular within the transport sector.

1.2 Target audience

The Deliverable is addressing a broad audience, mainly, but not exclusively, related to stakeholders that are dealing with Urban Transport Systems management (infrastructure owners & operators, TMC managers, (smart) city planners, transport engineers, public administration, employees, security services, etc.), emergency respondents, local and regional authorities, the general public, etc.

It is important to stress out the EU dimension that is in the heart of the UTS ERMG, and the RESOLUTE project as a whole, thus aiming to provide guidelines that not only address a single UTS as such, but also its links, dependencies and interdependencies with other transportation systems and other critical infrastructure, finally targeting to facilitating safety, security and, most notably, resilience as a core feature in EU cities, regions, networks and as a whole.

1.3 Structure of the document

The document is structured in five Chapters and one Annex. More specifically:

- Chapter 1 is the Introduction where the scope and objectives of the document are presented
- Chapter 2 is the Methodology. In this chapter it is described how the UTS ERMG has been updated, taking into account the results of the RESOLUTE pilots as well as the comments of the Advisory Board and the updated version of the generic ERMG. The updated and short versions that follow, are also introduced.
- Chapter 3 includes detailed instructions of how to use the UTS ERMG in practice, along with a relevant example.
- In Chapter 4, the updated version of the ERMG is included in detail, following a similar structure as in the D3.7, with updated contents, following the recommendations coming from the pilots and the Advisory Board.
- In Chapter 5 conclusions are drawn regarding the contents and use of the UTS ERMG
- Finally, in Annex A, the short version of the UTS ERMG is presented, highlighting the most important recommendations in a 1-page-per-function format.

2 METHODOLOGY

The first version of the UTS ERMG was issued in M12 of the project (D3.7, April 2016), including all the methodology for the definition of functions, their interrelations and the overall application of FRAM.

Since then, the UTS ERMG has been available online in the project website, accessed by several interested bodies and presented in several conferences and publications (see WP7 Deliverables). It was also, of course, used during the RESOLUTE project activities, first as a consulting document in the production of the tools and then as a guideline for the execution of the pilots.

Moreover, the RESOLUTE Advisory Board members were involved in the process, by reviewing the first version of the guidelines and suggesting ways for its improvement.

These sources were hence used to produce this updated version of the UTS ERMG. The work has been organised stepwise:

a) Assessment from pilots: input coming from the pilot assessment per guideline was evaluated and a list of guidelines needing further elaboration was produced
b) Advisory Board members' comments: the comments received from the AB members at several occasions were discussed and incorporated in the guidelines to the possible extend
c) Revision of the UTS ERMG per guideline: guidelines were revised following the recommendations from the above sources
d) Short version of UTS ERMG: a short, condensed and practical to use version of the guidelines was produced, following the original structure of the UTS ERMG, but in limited volume and highlighting the most prominent issues.
e) Finally, the updated version of the generic ERMG (Deliverable D3.6) has also been used, for the contents of the two documents to be aligned and consistent.

2.1 RESOLUTE pilots

The guidelines have been revised according to the RESOLUTE pilot results (See D6.4) carried out in Florence and Athens. The results of the assessment revealed some drawbacks in the ERMG definition. They have prevented their full application and understanding resulting in a low or null increment in resilience quantification score defined in D6.4. In particular, a taxonomy has been identified to assess guidelines, in D6.4 and is reported in Table 1.

Table 1 Taxonomy for guidelines assessment and revision

# TAX	Guidelines Issues Taxonomy
TAX01	too generic (no practical/poor practical indications)
TAX02	too specific/overdetailed (some references are not applicable to a wide range of the organization)
TAX03	not understandable (guideline quality of the description is poor)
TAX04	out of scope/focus (wrong target audience)
TAX05	incomplete (guidelines should be improved/extended)
TAX06	wrong content (guidelines recommendations seems to be out of scope for the guideline under specification)
TAX07	not applicable within the project timeframe (lack of resources)
TAX08	not applicable within the project timeframe (lack of technological knowledge/awareness/education)

TAX09	not applicable within the project timeframe (requires a policy change from the stakeholder)
TAX10	not applicable within the project timeframe (requires reorganization/change of the company and/or involvement of key stakeholder)
TAX11	not applicable within the project timeframe (irrelevant in the context of UTS system resiliency)

According to the pilot assessment results, the guidelines that required reviews are reported in the following table

Table 2 ERMG assessment results

Function	# TAX
ANTICIPATE	
Develop Strategic Plan	
Manage financial affairs	TAX01 - TAX03 - TAX09
Perform Risk Assessment	
Training staff, Citizens	
Coordinate Service delivery	TAX05 - TAX10
Manage awareness & user behaviour	TAX07 - TAX10
Develop/update procedures	TAX01 - TAX0 - TAX10
Manage human resources	
Manage ICT resources	TAX07
Install/maintain assets	TAX07
MONITOR	
Monitor Safety and Security	
Monitor Operations	
Monitor Resource availability	TAX04 - TAX05 - TAX06
Monitor user generated feedback	
RESPOND	
Coordinate emergency actions	
Restore/Repair operations	TAX01 - TAX05
LEARN	
Provide adaptation & improvement insights	TAX08 - TAX10
Collect event information	TAX01 - TAX10

These findings were used for the update of the generic ERMG and its adaptation for the Urban Transport System as Critical Infrastructure, i.e. the UTS ERMG presented hereafter.

2.2 Advisory Board

Upon issuing the first version of the ERMG (D3.5) and UTS ERMG (D3.7) they were made available to the Advisory Board members for their comments and suggestions for improvement. Additional comments were received during the Advisory Board meeting which took place in Brussels in parallel to the Joint Workshop DRS-7&14 projects and the Community of Users, in September 2017.

Through this consultation process several suggestions were received. These involved mainly the explanation of the use the guidelines, the provision of a shorter version of the guidelines, practical examples, indicators, etc. In the current version presented in the Deliverable in hand, there has been effort to address these suggestions and provide an enhanced and more useful UTS ERMG.

2.3 UTS ERMG Update &short version

Following the above findings and consultation process, the original version of the UTS ERMG has been updated and revised according to the results of the pilot assessment and the suggestions of the Advisory Board. In Section 4 the revised version is presented, following the original structure and incorporating improvements to satisfy the identified problems per function/guideline.

Moreover, a new, shorter version of the UTS ERMG has been produced, similar to the one of the generic ERMG, in which each of the functions/guidelines is summarised in one page, highlighting the main points in a short but comprehensive manner. This short version was specifically suggested from the Advisory Board members during the Advisory Board meeting in Brussels, in September 2017 and has been implemented in the current Deliverable in a specifically created template. The short version of the UTS ERMG can be found in Annex A of the present document, following the same structure and layout as the generic ERMG short version.

3 DETAILED INSTRUCTIONS FOR USING THE UTS ERMG

The ERMG aim to support a self-assessment and multilevel gap analysis in respect to the potential for resilience of the CIs considered. The ERMG are structured to support the reader in the assessment as well as improvement of the CI of interest. Guidelines may be used by CI stakeholders independently, in which case, some aspects of the guidelines may not be applicable. However, 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. To this end, teams and departments within organisations should establish and maintain regular communication with other teams and departments to which they identify as being operationally coupled. 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)

Often these couplings extend far beyond the formal boundaries of organisations or the system under consideration. Teams or departments within a given organisation are likely to have strong interdependencies with teams or departments within other organisations participating in the operation of a given CI. Going across organisational/system boundaries should not prevent the development and maintenance of suitable coordination mechanisms between operationally coupled system functions. Different degrees of formalisation and analysis should be defined in these cases, namely to ensure responsibility and accountability. To this end a 3-level analysis inspired to the 3 tier- resilience assessment approach defined in (Linkov et.al, 2018) is provided. In (Linkov at . 2018), the goal of each tier is to describe the performance and relationship of critical systems in order to identify management options that enhance performance in parallel with activities that reduce risk. The methods of Tier I quickly and inexpensively identify the broad functions that a system provides to human society or the environment and prioritize the performance of the critical functions. The methods of Tier II describe the general organization and relationships of the system in a simple form such as a process model or critical path model. The methods of Tier III build a detailed model of important functions and related sub-systems where each process and each component of the system is parameterized. The process can be halted at any tier when enough information has been synthesized such that actionable system investments or projects to improve system resilience, given available resources, have been identified by the decision makers (See Figure 2).

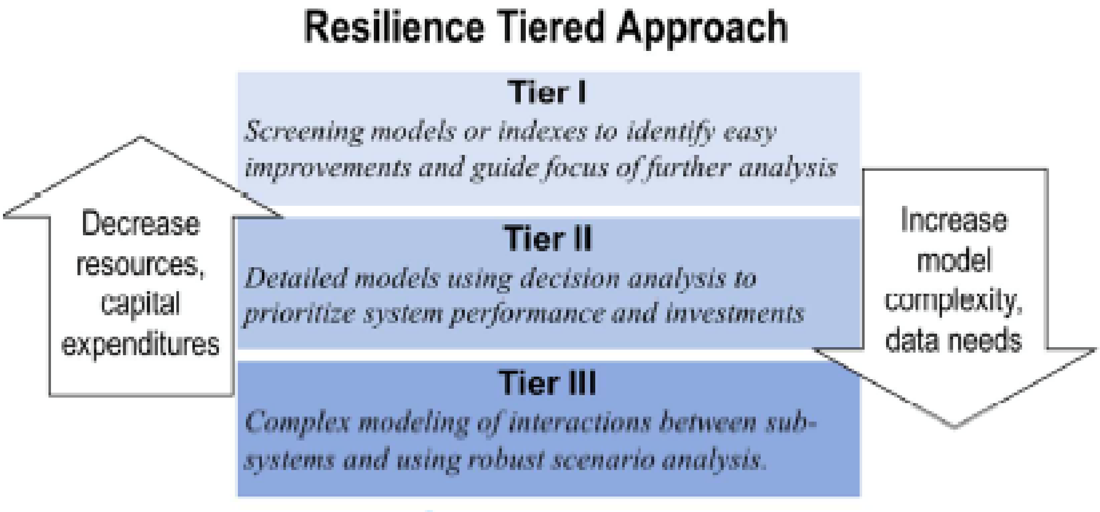


Figure 1: Resilience Tiered Approach (Linkov et. al., 2018

However, the focus should be set on real work and operational needs, as opposed to merely establishing formal business and legal requirements between the parties involved.

The FRAM model provided by RESOLUTE and used as grounds for the development of these ERMG, (D3.5) provides initial support to stakeholders in the process of identifying their interdependencies within their specific context and scope of operation.

To this end, the ERMG support three different levels of analysis:

- Level I: The first level of 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. The missing connections between functions in the CI assessed may suggest that information or resources are not properly supplied or shared, creating vulnerability in the system. This preliminary assessment is able to highlight relevant issues in the organization/system. This is a cheap, fast-forward and not necessarily structured approach able to guide a "first-glance" to the system. An eventual not satisfying result might drive decision makers in investing resources for a more detailed analysis to quantify the gap and related action to build resilience according to ERMG.
-
- Level II: The second level of analysis is more detailed, and it is 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 readers should be able to understand if general as well as common conditions and recommendations are applied and to which level of maturity. Moreover, indications and insights on how to improve capabilities to manage the variability of functions' output can be retrieved from the document. This level requires a more structured approach, where experts are engaged to assess how the variability of the functions and the potential for propagation along the interdependencies are addressed in accordance to the ERMG. An example of such kind of analysis is provided in Table 3, where a FRAM function is assessed looking at it actually works. The scale (Disagree-Agree) can vary according to the method of assessment quantification defined by the experts.

- Level III: The third level of analysis requires a resilience quantification exploiting data generated within the system (e.g. Smart City) in order to better details the gaps. At this level, functions performance and variability need to be quantified using real data aggregated through KPIs and methods to compose synthetic indicators. Even If the methods for KPI aggregation are given (see D6.4), the selection of which KPIs are relevant is up to the system actors/stakeholders. They need to reach a wide agreement on KPIs and data sources associated to the functions of the system before proceeding with the assessment.

In D6.4 is reported an example of resilience assessment and quantification whose results inform the decision makers about the existence of issues at fine grain level (function output).

Moreover, since a function that is coupled with another may be prevented from providing the expected outcome if the variability of the upstream function exceeds the capacity of the downstream function to manage it, ERMG needs to be understood to enhance the variability dumping capacity of a downstream function.

Table 3: Function "Monitor Resource Availbility " assessment in Level II.

Monitor Resource availability			
		Criteria	Source of function variability- Expert judgment based assessment (scale: Disagree-Agree 1-10)
General Recommendations			
1. Understanding the way in which interdependencies support the provision of critical resources. 2. Assessing the types and degrees of variability to which these are submitted in the face of pressures emanating from a system's operational environment.		1. Level of understanding is mature enough	6
		2. Variability is known in nature and amplitude	3
Common Conditions Recommendations			
Availability of resources	1. Technical and organisational conditions ensuring acceptable workload, managing fatigue and stress in order to anticipate negative effects on job performance, controlling workability across ageing, and promoting health, arousal and preparedness towards prompt reactions in emergency situations. 2. Ensure the required budget for the system functioning and emergency situations. 3. Preview the needs for external operations and the related budget.	1. Variability is known in nature; in amplitude; both	5
		2. Financial control is linked to operational demands and needs	7
		3. Regular contact and coordination with stakeholders under all operational conditions	4

Monitor Resource availability			
		Criteria	Source of function variability- Expert judgment based assessment (scale: Disagree-Agree 1-10)
Training & experience	1. Provision of conditions for the development of competencies with experience, as requisite for awareness on local conditions in the scope of overall operational understanding. 2. Ensure training for emergency situations in relation to the use of all resources.	1. Knowledge transfer processes exist; are mature; assessed	3
		2. Simulation and exercises and carried out and assessed	4
Quality of communication	1. Ensure conditions and resources for timely and accurate communication (both push and pull of information). 2. Use of reliable and purpose oriented (suitable for operational needs and conditions) communication technology, and of appropriate communication standards and language.	1. Information flows are known; monitored; assessed	3
		2. Human factors assessment of communication-based tasks	4
Human Computer Interaction & Operational Support	Adequate interaction with computer and other IT systems is critical for an effective use of information-based resources. This is frequently a fundamental support for the management and deployment of other types of resources.	Human factors assessment of IT-based tasks	4
Availability of procedures &	1. Procedures must take into account resource requirements and the conditions of access to such resources. 2. Planning for accessible infrastructures, taking into account	Review of procedures (regularity and identification of review needs) and link to	7

Monitor Resource availability			
		Criteria	Source of function variability- Expert judgment based assessment (scale: Disagree-Agree 1-10)
plans	type and volume of resource availability and of resource requirements.	change control processes	
Conditions of work	Condition of work must be aligned with resource availability, so as to ensure an efficient and effective deployment of available resources.	Human factors assessment of work systems	6
Number of goals & conflict resolution	Monitoring the adequate allocation and deployment of resources is critical for the management of trade-offs between operational goals and needs in such a way that safety requirements are not compromised.	Human factors assessment of work systems	6
Available time & time pressure	Time is the utmost critical resource without which the efficient and safe use of other resources can be compromised. Efficient use of time strongly relies on adequate planning.	Adherence to planning and planning change control processes	6
Circadian rhythm & stress	Shift work or roster conditions may impose the need for more flexible management and deployment of resources. Monitoring resource availability may become more complex due to increased diversity and variability of factors to be taken into account.	Human factors assessment of work systems and flexible management of work schedules	6
Team collaboration quality	Monitoring changes in resource availability and re-assessing resource requirements as operational conditions change, requires close cooperation within and across work teams.	Team building and leadership are implemented and managed	7
Quality & support of the	Organisational conditions are fundamental for the quality of resource planning and deployment, in particular when re-	Organisation is purpose driven and aligned	5

Monitor Resource availability			
		Criteria	Source of function variability- Expert judgment based assessment (scale: Disagree-Agree 1-10)
organisation	planning of resource management is needed.	with operational needs and conditions	
Interdependencies Recommendations			
1. Monitoring resources generates information on resource allocation and the understanding of their flows, which represents one of the fundamental tools for planning activities, both as a primary input and as indicators for the potential need of planning revision or reassessment. 2. ICT constitutes a fundamental resource for all operational and managerial activities. The failure of ICT services may critically compromise the operation continuity. The monitoring of these services should provide the ability to anticipate potential disruptions and the deployment of contingency resources (adaptive capacities). The same concerns exist for energy supply requiring anticipation as well and preview of contingency resources. 3. Keep updated information on the status and supply of critical resources constitutes a fundamental resource for the anticipation of potential needs for operational adjustments. 4. In case the ICT infrastructure needed to support the resource monitoring fails, a dedicated communication and periodic reporting channel should be established with the suppliers. Reporting data about the resource consumed		1. Existence and maturity of feedback loops	5
		2. Redundancy of ICT systems and their independency	7
		3. Regularity of updates	7
		4. Means for both the push and the pull of information on resource availability	6

Monitor Resource availability		
	Criteria	Source of function variability- Expert judgment based assessment (scale: Disagree-Agree 1-10)
should be provided "on demand" and on pre-determined period. 5. A specific protocol and procedures to promptly inform about resource delivery failure and the related causes should be defined in advance between the CI and its suppliers. Such procedures should be included in the emergency plan of the parties.	5. Integration of information and communication needs into operational procedures	4
Limitations		
1. Difficulty in updating the information on resources use. 2. Difficulty in assessing the situation and mobilising the appropriate resources. 3. Difficulties resulting from limited financial resources. 4. Difficulties resulting from unavailability of technological assets resulting from breakdown or lack of energy. 5. Difficulties resulting from low human performance due to fatigue, inappropriate workload or sleep deprivation. 6. Difficulties resulting from insufficient personnel.	1. The limitations are well known	4
	2. There is a plan to address limitation in short-mid term	5

The synthesis of the gap analysis obtained through resilience quantification, is synthetized through the Resilience Analyses Grid (RAG) tool. The RAG is used as a basis for the representation of the quantification of each of the four fundamental resilience capacities, around which the ERMG are built. A low score in one or more of the 4 capacities may drive decision makers in allocating resource in a more precise way (improving a specific function or set of functions) to maximise the impact for resilience enhancement in the system.

At the end of the assessment, the reader will have an improved and very detailed awareness about the key resilience factors and critical operation aspects within the CI in which they operate, namely regarding the status of the CIs analysed and what to do at operational, tactical and strategic level to enhance the resilience of the system.

4 UTS ERMG UPDATED

4.1 Anticipate

4.1.1 Develop Strategic Plan for UTS

Background facts

Within this risk environment, our critical infrastructures are inherently interdependent—domestically and internationally—and vulnerable both within and across sectors due to the nature of their physical attributes operational environments, international supply chains, and logical interconnections. In Urban Transportation Systems, critical infrastructures provide essential support to every socio-economic activity and, furthermore, the paths that convey people, goods and information, are the same through which risks are propagated. Hence, the critical infrastructure mission area requires a focused national strategy and supporting plans and operational structures appropriately balancing resilience with risk-informed prevention, protection, and mitigations activities that allow us to manage the most serious risks.

In the specific case of Urban Transportation Systems, strategic planning should aim to:

- ensure the level of service regarding mobility in the addressed urban area
- ensure the safety of the transportation network: this means ensuring transportation routes are available during a catastrophe and ensuring emergency access to the involved urban area, but it also mean a safe environment during regular operation, especially for Vulnerable Road Users
- build a comfortable, cost-effective, healthy and green mobility urban environment

Strategic planning involves a structure or framework, a set of procedures (both formal and informal), and of course content. Beyond these basic elements, the underlying assumptions about strategic planning are that the future can be anticipated, forecasted, managed or even controlled, and the best way to do so is to have a formal and integrated plan about it in place. Planning simply introduces a formal "discipline" for conducting long-term thinking about an institution, and for recognizing opportunities in and for minimizing risks from the external and internal environments in terms of both normal operation and emergency management situations.

Within this scenario, the Sustainable Urban Mobility Planning is the most important topic in the European Commission's Urban Mobility Package. The Sustainable Urban Mobility Plan concept considers the functional urban area and foresees that plans are developed in cooperation across different policy areas and sectors, across different levels of government and administration and in cooperation with citizens and other stakeholders.

General Recommendations

In the UTS, the responsible mobility agency should ensure the alignment of all mobility operators/actors internal operation when defining strategic plans, through:

- Attempting to gather board members and key employees together for planning
- Gather together all mobility stakeholders: mobility needs to be seen as a trasversal domain of the Smart City
- Establishing the overall mobility goals for the alignment. Mission statement should be reviewed periodically between ten or twenty years and the objectives must be finite, feasible, suitable, acceptable and achievable.

- Establishing adaptive capacities goals to more effectively align operations to achieving the overall goal. Methods to achieving the goals might include organizational performance management models that might imply the evaluation of specific mobility-related KPIs.
- Incorporating a “flexible” decision making process that does not lock the company’s future development into a rigid path, but rather constantly evolves to reflect information learned to make the best possible decisions.
- Securing the continuity to deliver cash generation through sustainable organization grow resources in view of including that information in the Strategic Plan.
- Producing a set of KPIs in order to monitor the evolution derived from the Strategic Planning
- Establish an effective business-government partnership with critical infrastructure owners and operators

Besides these general recommendations, it can be said that strategic planning in UTS is a continual process of examining the transportation challenges facing and identifying a plan of action to improve transportation system performance. Strategic planning in UTS is a process that develops information to help make decisions on the future development and management of transportation systems. It expanded the determination of the need for new or expanded highways, transit systems, freight facilities, and transportation terminals, their location, their capacity and the management of their demand. Typically transportation planning involves a forecast of travel patterns 15 to 25 years into the future with an aim to develop a future transportation system that will work effectively at that time. Strategic planning in UTS will have significant effects on mobility, economic development, environmental quality, government finance and the quality of life. Wise planning is needed to help create high quality transportation facilities and services and guarantee the resilience of the UTS infrastructure in case of disasters, at a reasonable cost with minimal environmental impact and at the same time while enhancing the economic activity. These activities should be integrated within the SUMP, that has as its central goal improving accessibility of urban areas and providing high-quality and sustainable mobility and transport to, through and within the urban area. It regards the needs of the 'functioning city' and its hinterland rather than a municipal administrative region.

Common Conditions Recommendation

1. Availability of resources

Humans (labour) – skills/competence

- Key stakeholders dealing with mobility should be involved in the process of policy and vision definition
- Consult with the relevant stakeholders involved in operational aspects of mobility management at the addressed urban area

Data & Algorithm:

- Rely the strategic planning on statistics derived from historical data
- Define measurable KPIs in order to evaluate in time the performances of the planning
- Collect that in multiple places and allow integrate and correlate transport data with data related to events, weather, people flow, etc.
- Use of standard documentation for processes definition and for data management (e.g., standard protocols for exchange of traffic-related data like DATEX)
- Use of official concepts and definitions and use an integrated approach

2. Training and experience

- N/A

3. Quality of communication

- *Support the planning activity by efficient shareholders and (internal and external) experts coordination and cooperation.*
- *Guarantee the availability, accuracy and understandability of the communication through standardized communication tools, protocols and languages among all actors involved in the mobility management in the addressed urban area*

4. Human Computer Interaction and operational support

- N/A

5. Availability of procedures and plans

- Creating an integrated strategic planning process to support the integrated framework
- Defining a strategic plan, coupled with review and maintenance of the strategy to ensure that they stay relevant over time in compliance to existing procedures and plans

6. Conditions of work

- N/A

7. Number of goals and conflict resolution

- Planning teams should be built taking into account the scale and timeline of the plan and should make goal statements that should be reviewed periodically between ten or twenty years; these objectives must be finite, feasible, suitable, acceptable and achievable

8. Available time and time pressure

- Planning milestones and deadlines should integrate degrees of flexibility to cope with planning quality requirements

9. Circadian rhythm and stress

- N/A

10. Team collaboration quality

- Adherence to the principles of collaborative planning through the development of mutual benefit relations also across sectors

11. Quality and support of the organization

- Clear decision making process and alignment of responsibility with accountability
- Establish a Public-Private Sector Partnership Framework to provide an excellent collaborative mechanism for improving infrastructure resilience
- Ensure senior sponsorship
- Encourage the links to other realities that have best practices in place
- Financial capacity of each stakeholder and emergency unit should be included in the Strategic Plan including the level of financial involvement of each stakeholder
- Service delivery cost, replacement service (e.g. buses in case of subway unavailability) should be evaluated and included in Strategic Plan. In order to make this evaluation, time for full repair of system and full recovery should be known from involved stakeholders

Interdependencies recommendations

- If the related variability exceeds threshold of acceptance in relation to adaptation and improvement, the strategic planning should overcome such issues establishing and promoting an enabling management culture on self-protecting, so that appropriate adaptation action is undertaken

Limitations

The guideline only highlights how a generic strategic plan for UTS should be produced. Nevertheless, the efficiency of the Strategic Plan itself depends of the quality of the defined strategies.
Lack of integration at planning level across sectors in the urban environment.

Examples

The Transportation Strategic Plan (TSP) is the 20-year functional work plan for the Seattle Department of Transportation (SDOT). The TSP describes the actions SDOT will take to accomplish the goals and policies in the Comprehensive Plan over the next twenty years. Therefore it can be stated that The Transportation Strategic Plan (TSP) will be the City's guide for managing Seattle's transportation system. http://www.seattle.gov/transportation/tsp_2005.htm

4.1.2 Manage financial affairs

Background facts

States, regions and cities are largely responsible for arranging public services funding and management together with private, as well as public local, companies, such as urban transportation companies. It is important to know in advance the amount of resources available to fund any recovery effort and understand any eligibility or documentation requirements for obtaining the funding.

Staff with knowledge of financial resources should be included as part of the pre-event recovery planning team to ensure that disaster assistance is effectively utilized. Financial affairs function is one of the prerequisites for any system current functioning and/or recovery as funds will be needed for managing full system recovery. Furthermore, financial affairs refer to urban road agencies (public administration/private concessionaire), urban rail (metro, LRT, tramway), bus operators, transit authorities, transportation hub operators (terminals, P+R), parking operators, city (air-) ports as urban gates.

This function interacts with all involved shareholders (new income, market extension, protect from finances loss, etc.) as well as with market and socioeconomic trends (user needs, new products/services, economic situations) and financial adaptation.

This function is activated during normal operation as well as for emergency cases. In the latter case, it must be activated from the very beginning of the emergency, receiving requests from emergency teams and analysing priorities. It would be appropriate not to end this function before critical emergency is finished and full recovery is attained.

To correctly operate, this function needs appropriate funding based on the strategic plan.

This function must provide the highest possible feedback to Coordinate Service delivery, Coordinate emergency actions, Monitor Resources availability, Use of services and Supply financial resources functions so that it can coordinate the financial management. This can be performed by direct communication or by continuously monitoring the operations.

It is also recommended that this function is particularly communicating and coordinated with Supply financial resources function.

During current operation, financial data should always be available for analysis in order to improve current functioning. In the case of an emergency, after the end of operations and full system recovery, all financial data should be made available in order to allow for analysis and possible improvement for the future.

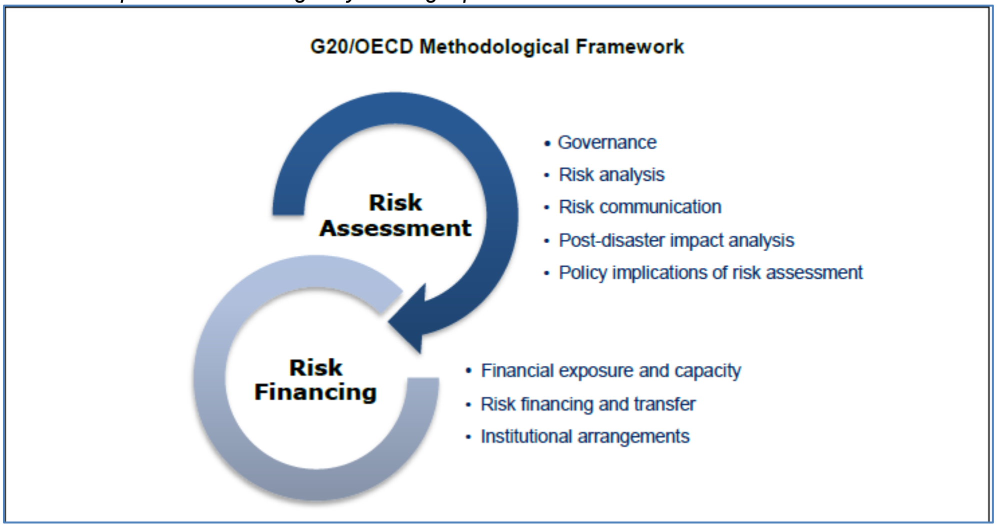
General recommendations

The aspects that should be targeted in managing financial affairs in order to increase resilience of a critical infrastructure can be summarised in the following:

- *Assess potential disaster impacts and negotiate insurance and re-insurance plans accordingly.*
- *Assess private disaster risk financing markets and financial sector resilience.*
- *Take into account the economic impact of system disruption*
- *Plan financial need for restoring access to transport of critical goods & commercial business as soon as possible*
- *To identify sources of brittleness in order to invest in their correction.*
- *Consider the role of business and economic development entities and include them in the pre-planning*

and recovery processes

- *Know and be able to use Governmental disaster risk financing tools.*
- *Identify disaster risk financing markets and institutional arrangements.*
- *Investigate government compensation and financial assistance arrangements.*
- *Ensure a fair and efficient deployment of funds.*
- *Develop financial control and plan financial assets in accordance to financial needs of the operation and financial obligations.*
- *Evaluate financial needs for emergency.*
- *Evaluate financial needs for complete system recovery.*
- *Analyse financial capacity of each involved stakeholder including private companies, governments, public companies…).*
- *Analyse capacity and financial resources possibly at institutional level e.g. county, city, state and at private lever e.g. private companies/operators.*
- *Define and agree on which part of recovery goes to public sector and which goes on private sector*
- *Identify and analyse ways to obtain necessary funds in case of emergency.*
- *Plan budget reserve in case of emergency needs.*
- *Plan cost-sharing procedures between involved stakeholders.*
- *Manage over-payment situations if any.*
- *Revise financial needs regularly in accordance with system and operational environment changes.*
- *Staff with knowledge of financial resources should be involved at all resilience stages: Plan, Absorb, Recovery and Adapt to ensure that disaster assistance is effectively provided.*
- *Analyse real finances use after a crisis in order to adapt procedures to be more efficient during next crisis*
- *Audit the results of planned financial management after the crisis and take the necessary conclusions to improve next emergency strategic plan*



OECD Methodological framework

Common Conditions recommendations

1. *Availability of resources*

- Humans (labour) – skills/competence
    - *Persons in charge of financial affairs for each department of the organization should be assigned.*
    - One person to be named and able to decide for the entire operation and a secondment able to

immediately overtake the operations in case of deficiency from the first one. Both not in the same place and reasonably far from potential crisis points in order to be kept safe for ruling operations.

  - Directory of names, telephone numbers, email, and alternative communication channels to reach them
  - Trained selected employees to manage financial affairs during emergency

- Budget
  - Availability of budget reserves for emergency cases.
  - Awareness of structures from which funds are available and how to recover them.
  - Define the cost of tools for crisis management (app development, control room setting…
  - Conflicting objectives should be managed during the strategic plan phase, in order to define priorities order and allocate funds accordingly. This strategic plan should be agreed by all involved parties in order to avoid conflicts during the crisis management.
  - Budget allocation should be revised once a year in order to take into account all possible evolutions for each of the involved parties.
  - Planning should allow a perfect matching between available and necessary resources. The matching between the two has to be taken into account during planning phase so that resources should be available quickly.
  - Each involved party has to calculate the necessary budget for recovery (emergency costs, repair costs etc.), communicate these costs to the monitoring party who will compile the information. Matching between necessary costs and available resources should be calculated in the strategic plan, taking into account resources available from each stakeholder but also from cities, regions, states, etc.
  - Reserve funds control during and after the crisis management, in order to avoid overpayments needs. In any case funds should be ready to finance full recovery even if this means more payments than planned reserved.
  - The allocation of supporting funds should be budgeted in relation to the UTS condition and relative risks for adverse/disruptive events. The portfolio should also have a wide margin of use because of the variability of each possible event in terms of typology, level of criticalities, extension and propagation from/to other urban Cis
  - Financial Planning should allow an optimum matching between available and necessary resources requested to address the strategy plan. The matching between the two has to be taken into account during planning phase so that resources may be efficiently and readily deployed.
  - Reserve funds control during and after the crisis management, in order to avoid over payments needs. In any case funds should be ready to finance full recovery even if this means more payments than planned reserved.
  - The allocation of supporting funds should be budgeted in relation to urban structure and relative risks. The portfolio should also have a wide margin of use because of the variability of each possible event in terms of typology, level of criticalities and extension.

- Data & Algorithm:
    - Use of project management concept and models to collect and monitor financial data.
    - Use data coming from all the systems collected to monitor and control the critical infrastructure during normal operation.
    - Reliability, Availability, Maintainability and Safety (RAMS) practices and algorithms for calculating the target thresholds according to the maintenance objectives.
    - Data/information collected by on field operators and citizens during standard infrastructure operation.
    - Collect and monitor financial data during & after emergency operation. - Analyse data after operation in order to obtain re-usable statistical data for the future, potential predictive models can be create, and unexpected relationships of those that with the events and actions.
- Training and experience
    - Training in terms of financial affairs, should be focused in the following areas:
        - *Financial management skills.*
        - *Project management skills.*
        - *Cooperation skills.*
        - *Public security, operational head skills.*
        - *Crisis management (well trained and experienced personnel in this field should head the operations).*
        - *Current operation skills.*
        - *Adaptability & capacity to adapt current functioning to possible emergency needs.*

2. *Quality of communication*
    - Communicate available resources to involved stakeholders
    - Communicate with stakeholders where resources are available in order to get funds quickly. - Ability to communicate quickly with operational teams in order to manage funds availability and fair distribution until full recovery
    - Submit detailed information about the financial status and recovery plan to stakeholders in order to establish transparent relationships and get funds quickly
    - Establish quick and reliable communication with operational teams in order to manage defunds availability and fair distribution until full recovery
3. *Human Computer Interaction and operational support*
    - Utilization of software tools to analyse financial data.
    - Utilization of software tools to plan and monitor budget and resources availability.

- Utilisation of software tools to communicate with all function and allocate funds according to the plan and the emergency needs.
- Utilization of software tools to simulate and analyse the costs of business continuity interruption due to disrupted system and evaluate economic impact on thee society.

4. *Availability of procedures and plans*
    - *Strategic financial plan in case or emergency ready.*
    - *Operational plan ready.*
    - Fast availability of necessary resources.
    - Procedures for financial resources obtention available and know by the involved financial managers of the crisis
    - Training on procedures use for involved financial managers of the crisis at least once a year
    - Common procedures available in public and private sectors in order to avoid time loss and/or mutual incomprehension
5. *Conditions of work*
    - Emergency work during crisis.
    - Ability to have all necessary involved persons of the structure back at work quickly even during break times
    - Manage to have “on call” persons able to reach quickly the offices in case of emergency
    - Ability to know priorities for recovery after crisis in order to disseminate funds properly.
    - Work in teams, able to immediately take over the current operations,, in case of long recovery.
6. *Number of goals and conflict resolution*
    - Necessary to define priorities in order to stop possible conflict in advance. - Define strategic plan and communicate it to involved parties so that they know where funds will go first and avoid conflict.
    - Give decision power to experienced people in order to avoid conflicts.
7. *Available time and time pressure*
    - During current operation, work is made under normal time pressure.
    - In case of emergency, immediate response is needed in order to call for necessary funds as quickly as possible and be able to give appropriate answer to operational teams.
8. *Circadian rhythm and stress*
    - *NAA*
9. *Team collaboration quality*

- Adherence to the principles of collaborative financial planning through the development of mutual benefit relations.
- Agree on collaborative financial planning between public and private entities before crisis
- Define mutual financial responsibilities
- Preliminary analysis of capacity in team working in order to avoid conflicts and conflicting payment orders.

10. *Quality and support of the organization*
    - Clear decision making process and alignment of responsibility with accountability.
    - Alignment of decisions with available resources.
    - Alignment of decisions with defined priorities.
    - Measurement of performance will be made after the emergency situation, in an early phase, in order to analyse used resources and remaining ones. Comparison should be made with what was planned in order to assess the validity of planning that was made and allow necessary adjustments to be made for future strategic plans. Second phase of analysis should be made after full recovery together with final used budget accounting. Financial reports have to be provided to each involved party and necessary adjustments have to be made in future plans based on final financial results. Deviations from initial planning should be analysed (why, how, how much) in order to better take them into account in future planning.
    - Interpretation of financial results should be made immediately after full recovery inn order to allow improving the strategic plan quickly and be ready in case of a new emergency situation
    - Coordination between all stakeholders should be ensured by knowing in advance the financial capacity of each one of them and producing a financial plan accounting the level of financial involvement of each entity in case of emergency and recovery procedures.
    - Cost of emergency action and cost of CI full recovery should ee evaluated in advance and financial planning should take this evaluation into account.
    - Constant monitoring of financial resources (incomes, expenses, financial involvement of each involved party) should be conducted during and after the emergency, during the recovery phase, until full CI recovery.
    - Monitoring of the use of financial resources should be centralized too only one point in order to allow better resources allocation depending on the urgent needs. Monitoring should respect what is planned in strategic plan but should also be able to adapt to urgency and reallocate resources quickly enough in case of urgent need that was originally not planned. Should also be able to adapt financial plan in case of reallocation needs.
    - The supply off resources should come from involved parties and stakeholders: service providers, cities, region, etc. Monitoring entity should be able to request funds quickly enough in order to be able to allocate resources in due time. It is needed to know in advance the way to obtain funds in order not to lose time during normal or emergency operation.

Interdependencies recommendations

In order to manage the potential issues generated by the strategy planning function, an organization should consider applying the Corporate Social Responsibility (CSRR); this is a corporate self-regulation, to align the business model to goals that emphasise accountability for the impact of actions taken on stakeholders and the broader community in which business operate. CCSR encourages efforts to achieve a sustainable, positive impact through corporate activities. It provides opportunities to enhance the perception of a company's integrity and reputation, and can help increase brand recognition.

This function must provide the highest possible feedback to Coordinate Service delivery, Coordinate emergency actions, Monitor Resources availability, Use of services and Supply financial resources functions so that it can coordinate the financial management. This can be performed by direct communication or by continuously monitoring the operations.

To operate correctly this function needs appropriate funding based on the strategic plan.

This function must provide the highest possible feedback to Coordinate Service delivery, Coordinate emergency actions, Monitor Resources availability, Use of services and Supply financial resources functions so that it can coordinate the financial management. This can be performed by direct communication or by continuously monitoring the operations. - It is recommended that this function is particularly communicating and coordinated with Supply financial resources function

Limitations

Possible limited financial resources of involved parties

Possible resistance of involved parties to plan a budget reserve in advance

Possible incapacity of involved parties to produce a strategic plan

Examples

a) Infrastructure Australia: Urban Transport Strategy from Federal government of Australia

This report discusses the development of a strategy for a national framework for planning, financing and managing urban transport infrastructure. The strategy would target city planning, transport services and investment in road and rail infrastructure. It would complement national strategies for ports, airports and freight. The report raises issues relating to the development of a national urban transport infrastructure strategy and suggests key principles to guide its development, considered with reference to systems, economic, social, and environmental and governance criteria.

b) A Pre-Event Recovery Planning Guide for Transportation, TRRB report

NCHRP Report 7533: A Pre-Event Recovery Planning Guide for Transportation (The Guide) provides an overview of what can be done to pre pare for the recovery of transportation critical infrastructure. Principles and processes based on federal guidance, effective practices and lessons from case studies are provided to guide transportation owners and operators in their efforts to plan for recovery prior to the occurrence of an event that impacts transportation systems. Tools and resources are included to assist in booth pre-planning for recovery and implementing recovery after an event. The Guide is intended to provide a single resource for understanding the principles and processes to be used for pre-event recovery planning for transportation infrastructure. In addition to the principles and processes, the Guide contains checklists, decision support tools, and resources to support pre-event recovery planning. Thee Guide will be of interest to transportation infrastructure owners/operators, transportation planners, and practitioners at the state and local levels.

4.1.3 Perform Risk Assessment

Background facts

Risk assessment serves the fundamental purpose of supporting both the definition of priorities for action and the determination of the nature and course of such action. Since its origins, risk management has evolved very differently depending mainly on the domain (i.e. industry, health care, services, etc.) and the nature of risk (i.e. industrial safety, occupational safety and health, security, economic and financial risk, etc.). This has resulted in a highly fragmented approach to risk assessment, which is reflected at organisational, normative and legislative levels.

High system complexity poses many challenges for risk assessment in all sectors. Transport systems may be increasingly challenging, mainly as a result of their dynamics, the frequent interactions in the environment and the continuous uncertainty. In addition, such interactions tend to take place beyond the scope of any organisational and geographical boundaries. Within this context, multiple risk factors emerging from system interdependencies require assessment tools that not only support integrated risk management practices but also, are effectively embedded into operational processes.

In the field of Transport, Risk Assessment serves the purpose of supporting the definition of priorities for action and the determination of its nature and 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.

General recommendations

Risk assessment should take into account the following:

- *Need for knowledge on shared risk amongst multiple transport stakeholders. This is particularly critical in the domain of security, which imposes the protection of sensitive operational information. Regular stakeholders' meetings or task forces addressing specific risk assessment needs, may provide the necessary basis for information sharing, whilst insuring that such information remains contained within a restricted number of people.*
- *Increased need for integrated risk assessment in order to facilitate coordinated risk management actions and measures. Within transport systems, a wide diversity of risk factors may interact at different operational levels (i.e. weather related, passenger safety and security, operation related). The regular and integrated assessment of such risk factors requires dedicated human, organisational and technical resources.*
- *Shifting from single "all purpose" tools to a set of integrated tools that respond to different risk assessment needs (i.e. local specific operations, global and interdependent overview of risks) that are able to exploit heterogeneous data generated within (operation) and outside (environment, usage) the system. As transport services become increasingly reliant on close cooperation between multiple stakeholders, sometimes across infrastructures managed by different entities, modal shifts at transport hubs must take place as seamlessly as possible.*
- *Adopting tools that are adaptive and provide the ability to continuously update risk assessment needs in view of changes in safety models. This requires the availability of dedicated resources and specially trained staff for carrying out risk assessment.*
- *Prospective and anticipation needs through the assessment of potential changes (both in terms likelihood and magnitude) in operations and their environment.*

Common Conditions recommendations

1. Availability of resources

Risk assessment may require measurement or detection equipment, but often sufficiently precise assessment methods, namely subjective assessment tools, may be used. This may be particularly relevant for gathering data on transport infrastructures and other engineering assets.
Human skills and competence, as well as historic and statistical data and the necessary budget, are all required.

- *Human (labour) – skills/competence*

- *Risk assessment activities should be carried out by qualified dedicated teams but always in coordination and relation with local operational staff. When the commissioning of new assets (i.e. vehicles or infrastructure equipment), or changes to procedures and rules are involved, most transport sectors require risk assessments to be carried out by certified experts, often acting as the regulators or on their behalf.*
- *To the possible extent, assessment activities should be carried out within teams that gather various relevant expertise, ranging from engineering (i.e. mechanical, chemical, etc.), and human factors, among others. An in-depth knowledge of processes and operations is fundamental.*

- *Budget*
- Risk assessment budget should account for the possibility of instrumentation and external expertise needs.

- *Data & Algorithm:*
- *Historic and statistical data provide essential support for risk assessment procedures:*
    - *Data sets should be reviewed periodically, in order to integrate new potentially relevant risk variables. This provides the means to integrate changes in risk models.*
    - *Data sets should include relevant variables of operational environment, namely economic and social outsets and forecasts.*
    - *Exploit Big Data generated by the personal smart devices and sensors as well as Open Data generated by organisations and public institutions to support risk assessment.*
    - *Within transport the crossing between asset performance data, service level and event related information offers valuable insight on the potential impacts and relations amongst multiple risk factors.*

2. Training and experience

- *Subject matter experts should be consulted in order to validate hazard identification and risk estimation.*
- *Experienced local staff may also provide useful input in terms of risk perceptions and operational processes insight.*
- *As transport systems operate across many different organisations and administrative regions, experienced local staff may also provide useful input in terms of risk perceptions and operational processes insight.*

3. Quality of communication
- *Ensure the accurate and timely communication of risk assessment outcome to all relevant actors in the organisation (e.g. decision makers, operators, etc.).*

4. Human Computer Interaction and operational support
- *IT systems are increasingly important for the effective reporting of hazards and risks, and the support of decision-making, for instance when reviewing safety cases.*

5. Availability of procedures and plans

- *Risk Assessment activities must be contemplated and integrated in business and organisational process description, as opposed to independent or “stand-alone” activities.*
- *In addition to periodical needs, operation, business and change control processes must call on risk assessment and determine when such activities are required.*
- *While transport authorities in most sectors and member states may impose risk assessment requirements for these cases, stakeholders directly involved with transport operations and dealing with operational assets should set the conditions for mandated risk assessment.*

6. Conditions of work

- *A suitable level of independency and autonomy should be formally ensured to risk assessment teams.*
- *Within transport, risk assessment may be carried out in the close proximity of moving vehicles or within transport infrastructures open to traffic, namely in connection with maintenance activities. The setting up of dedicated and planned safe conditions of work should be contemplated.*

7. Number of goals and conflict resolution

- *It is necessary to adopt tools that respond to assessment needs of different process stages: planning, operation, maintenance, decommissioning, etc.*
- *Precision (quantitative and qualitative) of risk assessment must match process stage requirements and objectives.*

8. Available time and time pressure

- *While time requirements for risk assessment may not vary significantly, time pressure should be kept to a minimum, so as to not compromise thoroughness and validity of risk reporting.*

9. Circadian rhythm and 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.*

10. Team collaboration quality

- *Team work may be particularly relevant when assessing more complex operations and when producing risk reports.*
- *To be effective in risk assessment, it is necessary to establish a collaborative environment among the different sectors and departments of the organization and the team dedicated to risk assessment.*

11. Quality and support of the organization

- *I Since the risk assessment may require interviews to operators, as well as workplace inspection, it is necessary that the senior management, to overcome possible ostracism, officially endorse evaluators.*
- *The clear and explicit organisational recognition of the critical role of risk assessment is a fundamental contribution for the robustness of risk assessment activities and their outcome.*
- *Some interaction with stakeholders may be relevant in view of estimating supply chain related risks, which may require some formal pre-established organisational setting.*

Interdependencies recommendations

- *Hindsight on events constitutes a fundamental input to risk assessment. This 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. This requires more than conventional accident and incident investigations.*

- *Team reviews and discussions based on a thorough description of events (as opposed to an identification of failures) can produce valuable learning experiences and support the development of adaptive capacities. Risk assessment should feed into all management and operation practices, namely through the identification of the need for procedure reviews, or the redesign of operation or technology, among others.*

Limitations

- *Resources are inherently finite. For risk assessment, this means that, on the one hand, assessment must be built and adapted to the inevitable limitations of available information, both quantitatively (the amount and volume of information) and qualitatively (the accuracy and reliability of information). On the other hand, assessment activities must always adjust to time limitations in terms of, both the different time scales at which assessments are needed (different stages and levels of decision making processes and operations), and the timeframe within which an estimation must be produced to support decision making.*

Examples

- *Risk fora that bring together teams involved in managing different risk domains, addressing in particular, the potential need to review risk models and assessment tools.*
- *Team reviews of risk analysis activities, mainly focusing on the interpretation of risk factors and their mapping onto real operational context and specific scenarios.*

4.1.4 Training staff

Background facts

Training is defined as all activities deliberately performed to enhance knowledge, skills, and abilities of UTS employees with the aim of enabling them to better perform their specific job and to contribute to the resilience of the UTS. The Training staff function needs to be analysed per transport infrastructure and service provider category and per staff category. The aim is to train staff for routine operations, safety and security issues and emergencies. The intention is to incentivize the staff to reduce risk behaviour and increase the effectiveness of their responses in emergency situations.

Staff categories pertain to Operations & Maintenance (transport service providers), Engineering studies & Construction site overseeing (transport infrastructure providers) as well as Administration. Staff can be in-house or subcontracted.

Training staff in an Urban Transport System means providing everyone with adequate knowledge to perform their job, and to develop skills and abilities along focusing on the impact their performance has on the UTS and its end users. A critical issue here is to make UTS personnel act responsible and professionally supporting and promoting a positive image and to act in accordance with the strategic aims of the UTS.

Following the description of training staff in D3.6: a training *curriculum* is a description of how the training is done and includes a specification of when, where, how, using which materials and based on which scenarios the participant is expected to acquire the desired knowledge, skills, and abilities. Therefore, in the UTS case it is important to decide who the involved trainees are (bus drivers, transit hub staff, transit operators etc.), where the training will be located (transit hub, office, pilot study etc.), how the training will be executed (in phases, participatory, surveying, assessing simulations, etc.) and which materials and scenarios will be used. For example, to train staff responsible for monitoring safety and security at a hub, we need (1) to collect and analyse data from CCTV cameras, (2) to simulate a response alert activation system, communicating data to police, traffic police and station security (agency and employees), (3) to record system performance timing, (4) to assess after the trial response time, quality of communication, execution performance, automated system performance etc., and (5) to collect feedback from trainees and trainers to improve the process and the training itself. This could be part of a more complete training program that will be performed periodically at the hub, and results and performance will be correlated.

Training is a key element to ensure resilience. In emergency situations, actors from different organizations need to collaborate efficiently in order to maintain or restore the UTS's operation and performance. Therefore, it is important to feature collective exercises with difference stakeholder categories in the training process. For example, in case of an event at terminal 1 of a metro station, the involved stakeholders are: metro terminal 1 security responsible staff, metro terminal 1 information displays monitoring staff, metro bus drivers reaching terminal 1 at a specific time period, station security monitoring office, complaints office of the station, travellers using metros form terminal 1, general public in the terminal 1, ticketing machines responsible staff, etc. All these actors need to communicate and collaborate effectively and timely to handle the event optimally.

General recommendations

It is important to develop and test the training material considering the aim of the training and the potential effects on the UTS's resilience. One should examine alternative methods to deliver the targeted UTS resilience level. Therefore, it is highly recommended to validate plans, rehearse key staff, and to test systems that are relied upon to deliver resilience. For example, the personnel needs to be trained to monitor safety and unfold security mechanisms without creating a disturbance in the general public when a possible terroristic attempt is spotted.

The staff should be trained to deal with the event optimally, avoiding a general panic affecting the general public, and timely to eliminate risks and disasters. The frequency of exercises and training depends on the threats assessed and the statistics (fatal road accidents, station attacks etc.), but should take into account the rate of change (to the organisation or risk profile) and outcomes of previous exercises (if particular weaknesses have been identified and changes performed). Optimally, if there is adequate budget, training should be a priority for the UTS and take place periodically with high frequencies for all UTS staff.

To contribute to the resilience of the system, training activities need to be organized in a manner that fulfils the following criteria, ensuring that:

- the allocation of resources to training is coherent with the overall strategical planning,
- undesired variability in the training's outcomes is reduced, and
- training activities are revised to take newly discovered requirements into account.

To achieve training objectives for the UTS, it is important to:

- Integrate disaster risk reduction into formal education programmes, i.e. training on trial simulations of traffic assignment after events, information polices to ensure safe movements in a transport hub in risky situations, VMS guidance to exit collision roads after event occurrence.
- Collect information and learn from past experiences, use UTS events as training case studies to drive knowledge from lessons learnt.
- Examine similar training programs, their results on UTS resilience and follow the best practices.
- Develop risk reduction training and capacity UTS infrastructure (within a hub, road selection etc.) at the city level.
- Work with local resources such as the Red Cross, universities, NGOs, teachers and others for a horizontal knowledge delivery approach. For example, hub personnel should be aware of CPR, since the majority of trips by elderly persons include public transportation modes.
- Focus on training priority target groups such as: public transport authorities and UTS emergency management authorities; monitoring safety and security for UTS responsibles; etc.

Common Conditions Recommendation

1. Availability of resources

Humans (labour) – skills/competence

- The collection of training requirements should be linked to feedback processes available to all members of the Urban Transport Systems; it should be based on mobility data and events considered as risky.

Budget:

- Budget planning should account for the working hours spent on training by both trainers and trainees, including external trainers, training materials, budget needs for UTS event simulation trials, training locations and/or infrastructure, working hours of HR specialists updating training procedures, and auditing or certification costs.

Data & Algorithm:

- Use official and standardized formats to describe training requirements and test procedures where applicable.
- Store documentation of trainings and tests according to legal regulations.
- Make collected data available for the general data aggregator to allow verifying eventual correlation of training and skill with performance assessments.

2. Training and experience

- Collect feedback from trainers and mobility simulation trials in order to improve the training process and material
- Prioritize training actions considering the role of involved parties (key actors to eliminate disasters and perform adequate procedures to protect vulnerable target groups) and critical role of transport infrastructures/services (for example in terms of a terrorist attack in a transport hub, it is crucial to prioritize information delivery services to people in order to provide safe guidance to an exit)

3. Quality of communication

- Support efficient coordination among shareholders and (internal and external) stakeholders/experts and foster cooperation among different stakeholder categories; make training objectives transparent to local authorities to streamline reactions to undesired events. Promote a “single window” information framework in order to avail combined information for all transport choices, modes, activities, processes.
- Guarantee the accuracy and understandability of the communication through standardized communication tools, protocols and languages. Use the same transport environment simulation trials, Unicode strategies and training material.

4. Human Computer Interaction and operational support

When choosing the method for delivering the training, the following recommendations should be taken into account:

- Classroom training should be chosen if basic knowledge needs to be learned and if individual differences between trainees do not seem to influence training efficiency. Example: theory classes for metro driving personnel.
- Simulator training should be used for practical skill acquisition if training with real-world objects is related to high risks concerning the health of persons or the destruction of costly equipment. Search and rescue exercises when the building (e.g., a transportation hub) is not available for a real-world drill.
- On-the-job-training or drills and exercises should be used for practical skill acquisition if training with real-world objects is not related to high risks concerning the health of persons or the destruction of costly equipment. Example: practical driving lessons for metro drivers.
- E-learning may be used if the contents of training are assumed to be relatively stable over longer periods of time. Example: Learning contents about the overall UTS organization.
- Game based training, simulating traffic and transit volumes in cases of events in urban road network and delivering messages to VMSs.
- Conduct safety and security trials at hubs to prepare for different scenarios.

- Implement collaborative games/procedures/communication trials among UTS stakeholders that need to deal with the same event and timely respond from different perspectives.

- Store data from UTS games training and analyse them considering the travel strategies of each UTS staff category developed in the game decision nodes. For example, in a simulation of movements in the road network, the VMS signal in a decision node might be “fatal accident, exit from the second exit ahead”. Collect reactions and strategies developed.

5. Availability of procedures and plans

- The definition of training objectives and curricula, as recommended in the general recommendations, should be formalized and be embedded within the UTS organization’s HR procedures (such as personnel acquisition, promotions, etc.). The procedures must be clear and properly communicated to trainers and trainees who participate in training activities.

6. Conditions of work

- It is recommended to appoint the UTS organization’s head of the HR department as a responsible to ensure that the conditions necessary to perform the trainings are created. This includes the provision of space, materials such as media and consumables, budget and buffer personnel to account for the temporal unavailability of trainers and trainees to standard operations. In cases of trials at stops, road and hubs, training activities must not impede travellers’ movements and not affect nonparticipants (testing measures against terrorist attacks in a hub terminal should not affect hub users or spread panic. Instead, it should be communicated to the public that it is a trial and, if appropriate, the public should be encouraged to watch the trial training of the personnel as a measure of increasing awareness).

7. Number of goals and conflict resolution

- Often, restrictions in time and budget will make it impossible for certain employees to achieve all possibly defined training goals, at least within the desired timeframe. To resolve such conflicts, training objectives and subsequently training curricula need to be prioritised. To prioritize training activities we need to address the following questions:

    - Is this training legally required for standard operations?

    - Is this training legally required for relevant emergency situations within the UTS?

    - Is this training directly relevant for life-saving in emergency situations that may happen in the UTS?

    - Is this training relevant to create buffer capacities for emergency situations that may happen in the UTS?

    - Is this training relevant for improving the efficiency of standard UTS operations?

    - Is this group of staff that will be trained more critical to deal with UTS emergencies?

    - Is the training material in line with the current working conditions in the UTS and does it reflect actual needs covering possible threats in the UTS?

    - Are the training plan, methodology and time/location frame in line with the training objectives and does it support the UTS’s aims of training (feedback)?

8. Available time and time pressure

- Schedule trainings according to predicted demands: for example, perform metro hub trial at times the metro does not operate (night or early morning hours).

9. Circadian rhythm and stress

- Perform trainings during regular working hours unless the training requires a specific setting or infrastructure that is highly used by the general public, or unless parts of the training are confidential (such as counterterrorism tactics). For example, drills regarding a terrorism attack at a metro station trial should be conducted at late night hours when the metro is closed. Trainings should always avoid an excess of workload for both trainers and trainees. It is important not to press trainers and trainees but develop training programs that aim to transfer the targeted level of knowledge to participants without stressing them. Exceptions may occur in drills that provide participants with limited time to respond and restore the UTS to previous conditions, with the aim of learning how to cope with such restrictions. .

10. Team collaboration quality

- Provide training on the principles of collaborative actions to all strategic management actors in the UTS (transport authorities, infrastructure managements, UTS decision making representatives etc.).

- Provide training on collaborative UTS crisis management to all crisis management teams (monitoring UTS safety and security staff, traffic police, UTS decision makers, etc.).

- Provide team development interventions to recently formed teams and examine reactions and performances across different collaboration schemes (e.g., metro driver together with hub responsible dealing with a fatal event in the metro lines, and for the same event trial-test hub responsible and terminal security interaction).

- Provide trainings that increase awareness and understanding of vulnerabilities and respective mitigation strategies (e.g., an event causes destruction to the ramps, reduced mobility elevators and similar accessible paths in a hub; consequently, 100 reduced mobility persons are trapped there). When on-the-job training is applied and experienced professionals are supposed to act as trainers, the training effectiveness should be evaluated by another, independent trainer.

11. Quality and support of the organization

- The UTS organization should support training actions and prioritize training activities. Moreover, transport experts or employees ranked higher in the UTS's hierarchy could monitor training activities and organize the groups of trainers.

- To achieve a high quality of training, the following techniques could be applied:

    - Role-playing (e.g., a bus driver takes the role of the public transport authority's decision maker and proposes a strategy for an event).

    - Scenario-based training (e.g., bridge collapse and traffic simulation in the centre of London).

    - Training for role improvisation (e.g., security alert system collapse and event situation in hub).

Interdependencies recommendation:

- Monitor Safety and Security is related with training security staff to properly interact in UTS events

- Defining procedures includes the training procedures, limitations, guidance and standards that should be followed

- Perform risk assessment takes feedback from the training activities to assess risks in the UTS
- Coordinate Service delivery creates training requirements
- Regulate domain and operation is relevant for the training procedures regulation and training operation
- Coordinate emergency actions has to give input to the development of the training objectives and materials
- Define procedures for training (locations, time, involved UTS stakeholders etc.)

Limitations

- The usefulness of training as a measure to increase the UTS's resilience should not be limited to the training for specifically known and anticipated risks and to the training of meta-competences (such as team-work, participative leadership, team-based problem solving, etc.). Training on aspects such as the overall knowledge and understanding of UTS operations or the flow of traffic/transit information can be useful towards enhanced urban transport resilience. However, the management, implementation and assessment of such training initiatives may be challenging. In some cases, implementing cross-sector/department exchange of knowledge and expertise can benefit this purpose.
- The use of a guideline-based training approach has its limitations with respect to the training of target groups that are not identified as a finite number of known individuals, such as transit travellers, drivers or other stakeholders.

Examples

- Driver training in driving simulators and in vehicles without passengers for beginner drivers of trains.

4.1.5 Coordinate Service delivery

Background facts

The function aims at coordinating service delivery during ordinary /normal operation, as well as during and after incidents/disruptions of normal service.

The function aims at coordinating transport service delivery during ordinary /normal operation, as well as during and after incidents/disruptions of normal service. Coordination of transport service delivery before a disruption, concerns business as usual and standard communication and operation procedures should be used. Coordination of transport service delivery during or after an incident/event requires the implementation of emergency rules and procedures as well as wider communication and coordination with first responders. Post – event coordination of service delivery should focus on implementing alternative scenarios according to emergency plans and procedures and risk assessment based on the strategic transport plan.

The coordination of urban transport (UT) service delivery involves all aspects of providing urban transport service and all relevant stakeholders. In particular, aspects to be considered may include:

- Public transport service with Operation Control Center (OCC)
- Transport infrastructure (road network infrastructure, shared rail/road infrastructure, transport hubs)
- Traffic Management Center (TMC)
- Paratransit management
- Accessibility management (parking/park&ride/kiss&ride, pedestrians, cycling)
- Integrated smart ticketing & telematics
- Information to the public (language-independent or multilingual, through different sensorial channels)
- Timetable coordination (dynamic/schedule based)

General recommendations

An overall supervising authority responsible for the coordination of transport service delivery should be established. Specific transport service providers should follow compatible operation, maintenance and emergency procedures. Safekeeping and cross-labelling of incident inventories should be given priority. Immediate communication and information of management staff for all potentially severe incidents subject to immediate risk or other system weaknesses relevant to health and safety needs.

Access links to transport infrastructure for service provision should be planned, defined and communicated by overall supervising authority to service providers. Alternative access routes should be planned and communicated to transport service providers in cases of service disruptions.

Establishing a channel to collect user generated feedback on transport service effectiveness is also important in the coordination of transport service delivery both in emergency and daily operation.

Understanding the transport network criticalities as vulnerabilities, critical nodes/hubs, etc.

Specific recommendations depend on the Operation Plans of urban transport providers as well as on the mobility patterns (transport demand) in the area under consideration.

Sharing transport information with authorities involved in the transport service as first responders, city council, etc.

Maintaining control on the entire supply chain (fuel, energy, spare parts, etc.) in order to immediately react and adapt the transport service to changing conditions in resource availability (e.g. grateful degradation strategy of the service).

Common Conditions recommendations

1. Availability of resources

Humans (labour) – skills/competence

- Consult with transport service providers and the general public (transport surveys), for operation requirements, including required skills and competence of staff.
- The Transport Delivery Manager is the organization front end for the service point of view, person-oriented leadership is needed.
- -Problem solving: in depth understanding of user problems and demands and attitude to support user with a long lasting solution to run their business effectively and efficiently. Capacity to think complexity, considering her transport organization as part of a complex system instead of adopting a narrow point of view, cantered on the organization itself.

Budget:

- Provide adequate budget for the service delivery in the Strategic Transport Plan. To perform the function, adequate budget should be provided per transport provider. Transport service demand impacts appropriate budget allocation.

Technical equipment:

- State of the art technical equipment, components of transport infrastructure (mainly road and rail) as well as vehicles and transport applications of ICT infrastructure (e.g. Variable Message Sign panels, Operation Control Centers, Traffic Management, integrated smart ticketing) should be used, including a resilient internet network covering all areas of service delivery.

Data& Algorithm:

- Prepare maintenance reports, emergency response status reports
- Prepare maintenance status reports for transport infrastructure, vehicles and equipment at predefined time periods.
- Emergency Status reports required to perform the function following an incident /disruption of transport service.

2. Training and experience

- Staff should be adequately trained to implement relevant rules and procedures (e.g. operating, communications procedures, safety and security procedures). Staff should be periodically tested for adequate training and knowledge of routine and emergency rules and procedures to catch up updated operating procedures. Staff should also be trained for transport applications of ICT infrastructure.

3. Quality of communication

- Clearly define all potential communication channels among stakeholders(VMS, information signs, maps), provide emergency communication plan

- Use standardized communication tools, protocols and languages

4. Human-Computer Interaction and operational support

- Provide operational support for use of ITS, training procedures and suitable software to assist responsible personnel.

5. Availability of procedures and plans

Ensure that clear operation plans and emergency procedures and plans are available (or easily accessible) to all actors involved in the service and first responders.

- A responsibility matrix, operating, safety and emergency rules and procedures as well as trained staff are preconditions of the said function. Preventive and failure-driven maintenance of transport infrastructure is essential precondition of the function too.

6. Conditions of work

- Ensure best possible conditions of work, considering air quality and lighting conditions for metro service staff as well as drivers work in urban road traffic conditions.

7. Number of goals and conflict resolution

- Establish conflict resolution procedures in case of different orders by ordinary upper level staff and emergency staff.

- The decision to increment the transport service performance (frequency, capacity, etc.) to address unexpected increment of demand should take into account the safety and security requirements. In case such decision conflict with goals of other organizations, because of the interdependencies of the infrastructures, a prompt communication to each stakeholders affected by the decision is required in order to allow a synchronised systemic response to an unexpected event.

8. Available time and time pressure

- Ensure a degree of flexibility when planning milestones and deadlines to cope with quality requirements (e.g. considering itineraries, time of first and last buses close to metro stations should be close to time of first and last trains to achieve timetabled transfers in marginal times.).

9. Circadian rhythm and stress

- Ensure compatible nightshifts for (especially maintenance) staff of various transport service operators
- Train driver recruitment procedures should include psychometric tests

10. Team collaboration quality

- Take into account team collaboration competences when recruiting personnel
- HR management of transport providers should assess the strength of a potential employee to hold colleagues together, to gather/report information to colleagues and 3rd persons, to trust and respect his/her team and to coordinate/integrate with others.
- Establish mutual performance monitoring procedures.
- Team performance at each transport unit level is an essential KPI over and above individual performance metrics.

11. Quality and support of the organization

- Establish clear decision making process and alignment of responsibility with accountability
- Perform regular audits to check the need to update operating procedures following specified time periods
- Perform audits to check the need to update operating procedures following disruptions of transport service

Interdependencies recommendations

- Apply emergency exercises and emergency communication plans to coordinate transport emergencies effectively.
- Use maintenance procedures for physical /cyber infrastructure that take into account transport service peaks, to adjust to more critical availability needs.
- Efficient coordination of transport service delivery should also take into account user behaviour and awareness of service characteristics through both adequate information supply to users and surveys.

Limitations

- Legal framework and/or internal policy of transport operator may impose limitations to recommendations in particular on the adoption of data sharing approach or the creation and maintenance of a dialogue with users.

Examples

USA Department of Transportation (DOT)

- USA Department of Transportation (DOT) and its partner agencies, have juggled the roles of funder, owner, operator, guider, and regulator of the Nation's transportation infrastructure to coordinate UTS service delivery and build resilience in the transportation system.

Transport Scotland and Scottish Environment Protection Agency (SEPA) coordinates service delivery to deal with Flood Risk Management

As Local Flood Risk Management Plans are developed, Transport Scotland will aim to provide information on how trunk road drainage assets might impact on Potentially Vulnerable Areas (PVAs), as well as understand how flooding in the PVAs might impact on trunk road operations. This will be augmented by our Disruption Risk Management process which will improve understanding of known flooding locations, and deliver mitigation plans and improvement programmes.

4.1.6 Manage awareness & user behaviour

Background facts

This guideline is directed to UTS infrastructures that are used by passengers or other persons who are not related to the infrastructure through an employment status in the UTS organization managing the infrastructure itself or in another organization professionally related to it.

In order to anticipate, detect, or recover from an adverse event, such as a service disruption, the collaboration of the end users or the public may liberate important resources. Therefore, an ex-ante designed strategy for managing user awareness and user behaviour can lead to a higher organizational efficiency in terms of how resilience is achieved.

Managing user awareness and user behaviour may include short-term and long-term actions. Ad-hoc-communication is the tactical information immediately given to the users, such as information about delays or evacuation routes via signs and P.A. systems. Long-term actions may include the provision of general information through smartphone applications and internet platforms, printed posters with instructions for emergency responses (wheelchair exit routes from stations, alternative routes, etc.), organized events to raise awareness and inform UTS stakeholders, trainings for children organized at schools and for the elderly organized at open care centres, and similar means of communication that are not meant to produce immediate effects.

Manage awareness and user behaviour in the Urban Transport System refers to the level of awareness of different travellers that is considered adequate to support safe and secure behaviours in cases of UTS corruptions and emergencies. Therefore it includes a list of elements like:

- Signalling, awareness, stakeholder communication, training, etc.
- Surveys – communicating outcomes
- Training (material, emergency simulation),
- Dissemination channels (media, leaflets)
- Clear communication of guidance in case of emergency (signing, alternative sensory channels for providing information, info on alternative modes/routes, multilingualism or language independent information)
- Software apps
- Education of special groups (kids, elderly, disabled, etc.)

Safety and emergency awareness of the general public in the view of severe disruptive events in the UTS is of great importance. In this light, it is particularly recommended to promote safety-relevant behaviours through public communication via information and graphics in vehicles and hubs, as well as through public education institutions.

In case of emergencies, guidance for affected travellers is provided through signage, the public address system of the transport provider, and VMS panels (indicating alternative modes/routes) in road arterials. Special attention should be given to alternative sensory channels for visual and hearing impairments, along with instructions for handling wheelchairs during emergencies.

To incentivize travellers to adopt resilient mobility behaviour, the following means may be used:

- TV and radio advertising, and information on UTS resilience and proper behaviour of travellers.
- Software apps for mass alerts and bulk SMS that may instruct people on the move in cases of emergencies
- Station/ terminal/ road advertising
- Training material and training findings (from training staff) can be used in campaigns for the general public to build UTS resilience etc.

The reduction of the perceived public risk influences positively peoples' cognitive & affective judgment of risks and effectuates panic prevention. Awareness campaigns aim at developing enhanced confidence to the transport system.

General recommendations

Develop engaged communities with active participation of community members. Foster awareness and responsible behaviour regarding their travel habits, along with the teaching of common knowledge about disaster risks in the UTS, the most relevant factors that lead to disasters, as well as the actions to be taken individually and collectively in order to reduce exposure and vulnerability to hazards. The entire community must be informed about Urban Transport Risks (from traffic collisions to metro/airport terrorist attacks). Particularly, citizens should be enabled to respond correctly to local early warnings.

All communications to the users or the public should be based on a communication plan that contains a justification and the objective of each message, the media and channels to use, the expected results and a timeline for delivering the message.

Governmental support and the support by private or public organizations should be sought to implement long-term actions such as campaigns or educational programs for raising public awareness about citizen safety and disaster risk reduction. Anniversaries of past disastrous events are recommended for the implementation of campaigns, along with events to raise awareness.

Public awareness campaigns are recommended, if:

- A new type of adverse event has been added to the risk analysis, and the cooperation of the public is required to reduce the risk or increase buffer capacities.
- It has become clear that the general public is unaware of the risks related to a certain type of event and/or safety advice from the organization has not been followed by the public.

Plans and procedures for ad-hoc communications need to be aligned with mitigation strategies for anticipated events or disruptions.

Depending on the objectives of certain communications, partnering with public bodies is recommended in the following cases:

- Schools or other public educational institutions should become involved in increasing public awareness, particularly if children may already contribute to safety (which is rather the case in public transport than in individual road traffic). Work with educational authorities, key transport experts, and transport researchers in order to include disaster risk reduction at all levels of the school curriculum and in all UTS-related public and private institutions. Seek necessary technical support for curriculum development from UTS related institutions and agencies.

- Design the communication strategy around the addressability concept (4R - right people at the right time in the right place through the right channel).
- Work with partners to deliver a joint service (exhibitions and advice provision) to the community.
- At individual user request, provide 1:1 “how to ”advice (e.g., contacting local authorities and other organizations, as well as providing advice on how to protect themselves and their property against future events)
- Establish a people-centered early warnings system to empower individuals and communities threatened by hazards to act in sufficient time and in an appropriate manner to reduce the possibility of personal injury, loss of life and damage to property and the environment.
- Establish a cooperation of privately owned infrastructure operators and public bodies across sectors and borders, as well as with local communities such as citizens organizations, business, academy, NGOs, and local and regional government, in order to enable a multi-dimensional response to problems and needs.
- Communication systems should be community-centered rather than agency-centered, thus tailored to meet the needs of every group in every vulnerable community.
- Consider the use of social marketing and an evidence-based approach.

Common Conditions recommendations

1. Availability of resources

Humans (labour) – skills/competence

- The task of managing long-term campaigns on awareness and user behaviour should be performed by experts in public relations or marketing. The responsible for UTS service delivery and mitigation of disruptions should be included when defining such campaigns.
- Consult with transport service providers and relevant stakeholders, safety and security trainers, transport professionals, for operation requirements, including required skills and competence of them.
- The task of managing ad-hoc situation awareness and user behaviour should be performed by specifically trained staff. Training should include contents on travel behaviour in emergency situations and evacuation behaviour of large groups of people.

Budget

- Provide an adequate budget for proper signalling, educational campaigns, TV spots, training material including educational material for transport safety and security, promotional material for environmentally friendly user behaviour adaptation, campaigns, response guidance material, development of software apps for mass alerts plus bulk SMS able to instruct people on the move, salaries of staff responsible for the training, and development of the previous.
- Budget planning should account for the required communication infrastructure within the UTS, as well as for the planning of the procedure itself. Certain channels, such as social media, need constant attention to be maintained functional and thus require adequate budget availability.

Technical equipment

- State of the art technical equipment (pcs, simulators etc.), components of transport infrastructure (mainly road and rail) as well as technologies for alerts (applications) should be used, including a resilient educational and awareness internet network covering all areas of service delivery.

Data & Algorithm

Collect and exploit statistical data to tune and improve the communication:

- evaluate mode/route choices and shifts.
- collect feedback from the trainings/awareness campaigns/ lessons learnt sessions.
- understand risk perception and risk evaluation by the local users.
- estimate social media usage for trips made and UTS related information exchange among travellers.
- know the carpooling and car-sharing usage.
- know peak hour traffic and transit assignments (test for differences before and after campaigns).
- estimate ticket purchase rates/ station flows.

2. Training and experience

- Assess the level of awareness after informing travellers about the consequences of their selected travel options.
- Assess the level of communication among travellers and decision makers/ UTS employees and/or authorities.
- Train the UTS's responsible staff for safety and security issues in resilience management of UTS.

3. Quality of communication

- Use predefined messages or message types should in anticipated situations, such as different types of emergencies, in order to ensure the content quality of such ad-hoc messages.
- Test the different communication channels and tools before using them in emergencies in order to ensure they have the desired effects and to ensure that each channel is used in an appropriate manner. Collect feedback from recipients and stakeholders.
- Assess the quality level of communication in correlation with the users' behavioural changes and their levels of awareness. Use checklists to ensure accessibility, inclusiveness and interoperability of the communication for all. Define different levels of quality of communication based on user clustering/level of understanding and mean of communication (SMS, application, TV spot, printed material etc.).

4. Human Computer Interaction and operational support

- Applications provided to the users should undergo usability testing to ensure their helpfulness during emergency situations. Therefore, it is recommended to develop smart apps to raise the awareness about UTS risks, to inform about alerts and to communicate facts (from lessons learnt by similar UTS resilience management efforts). Moreover, the communication methods need to be selected based on their scalability and sustainability. Recommended actions include:
    - Support interaction through social media accounts of users and promote relevant material (connect them to travel together/ share experiences/ interact)
    - Develop a user platform to include all the above and have citizens interact and be tested in trial scenarios of UTS disasters
    - Use computers/apps and ICT infrastructure to inform users about the evacuation route planning in cases of emergencies along with reduced mobility people guidance

5. Availability of procedures and plans

- Develop procedures and plans to guide communication activities. (i.e. VMS messages, rerouting), promotional activities (i.e. UTS awareness TV/radio spots for safe and secured movements), the sharing of information, and data collection. A strategy should be created for long-term communications, such as campaigns for safe movements in a transit station in cases of UTS events, or procedures to follow for reduced mobility persons.

- The procedure for delivering ad-hoc messages should be defined, including general standards for the communication and specific messages/communication actions for predefined situations. This includes the use of channels and precise phrasing in order to be accessible by all kind of travellers.

6. Conditions of work

- The staff responsible for ad-hoc communications needs to be continuously provided with status information or orders from the coordinators of UTS service delivery or mitigation.

7. Number of goals and conflict resolution

- Conflict resolution procedures need to be established in case of different orders by ordinary upper level staff, emergency staff, and staff responsible for reduced mobility persons. Moreover, there should be individual/ personalized communication on evacuation procedures providing specific information for travellers with special needs. Communications should specifically aid vulnerable groups, for example by naming accessible exit routes in the case of fire in a transit hub.

8. Available time and time pressure

- Ensure a degree of flexibility when planning milestones and deadlines to cope with quality requirements.
- Prioritize actions and movements (safety first, reduced mobility persons and young children first).
- In emergency situations, communications related to safety issues should always be prioritized and be accessible by all travellers (with attention to reduced mobility and special needs ones). Campaigns that encounter time pressure, for example due to metro station corruption, should rely on social media strategies and news agencies to deliver relevant key messages and real- time information to travellers.

9. Circadian rhythm and stress

- NA

10. Team collaboration quality

- For managing awareness and user behaviour it is important to have a high quality collaboration among public UTS authorities, TMC, and road operators in order to act in a collaborative framework of user awareness (VMS information strategies, safe routes prioritizing, etc.).

11. Quality and support of the organization

- UTS authorities and key decision makers should achieve a high quality of communication and support common targeted decisions for UTS resilience.

Interdependencies recommendations

Manage awareness and user behaviour is connected with:

- Monitoring user generated feedback, assessing the level of awareness and behavioural changes towards resilient movements
- Collecting event information, providing input from travellers and tracking behaviours in cases of UTS emergencies
- Coordinate service delivery, Monitor operations, Manage ICT resources and Use of the service to frame the awareness process and user behaviour strategies and standards in accordance with the UTS resilience plan
- Monitoring Safety and Security as part of the monitoring plan and process
- Coordinating emergency actions, since travellers should be aware and able to behave properly in cases of emergencies

- Monitoring Resource availability, to develop awareness campaigns.

Limitations

- The effects of UTS awareness campaigns and communications are never guaranteed. The UTS staff responsible for managing awareness and user behaviour should always be prepared to face undesired user behaviours and deal with these.

Examples

ATTIKO Metro Athens

- Partnering between a local metro company and the local government to promote alternative routes for cases of flooding.
- Planning of evacuation routes from a metro station for different user groups, including vulnerable users such as wheelchair users or persons with diminished eyesight.

4.1.7 Develop/update procedure

Background facts

The purpose of Standard Operating Procedures (SOP) in Urban Transportation Systems (UTS) is to ensure smooth transportation links at both city and regional level generally and especially within emergency context, where quick and safe movement of material and humans are a priority. It should coordinate the use of transportation resources to support the needs of emergency support forces requiring transport capacity to perform their emergency response, recovery and assistance missions. In particular it should guarantee the level of service and safety at hotspots across the transportation network.

Therefore, the final scope of this function in case of UTS is to assist in the coordination of travellers, vehicles, equipment, and the transportation facilities necessary for support of short and long term response and recovery operations in case of emergency or special events.

General recommendations

To contribute to the resilience of the UTS, some general considerations should be taken into account when developing/ updating procedures:

1. Identify the goals and objectives for the emergency response procedures by defining what exactly the addressed emergency response team should do (e.g. evacuation of disaster area through public transport and government vehicles, limit the access to the disaster area, cleaning and reparation of access routes).
2. Review hazard or threat scenarios identified during the risk assessment phase for the addressed UTS
3. Assess the availability and capabilities of resources for incident stabilization (e.g. evacuation of disaster area through public transport and government vehicles, limit the access to the disaster area, cleaning and reparation of access routes) including people, systems and equipment available within the addressed organisation and from external sources (public emergency services)
4. Involve all public emergency services (e.g. first defence, fire, police and emergency medical services) to determine their response time at city level, knowledge of the addressed urban area and its potential hazards and their capabilities to stabilize an emergency at the addressed urban area
5. Determine if there are any regulations (e.g. LTZ accesses, one-way routes) pertaining to emergency procedures at the addressed facility; address the management of existing regulations in the plan
6. Define protective actions for life safety (evacuation, closure of access to the disaster area, communication through all available means: VMS, web portal, mobile APPs, ecc. & control through all available means: UTC, LTZ, etc.)
7. Develop hazard and threat-specific emergency procedures using guidance from existing material and by using experience derived from former events
8. Coordinate emergency planning with public emergency services to stabilize incidents involving the hazards at the addressed urban area
9. Train personnel so they can fulfil their roles and responsibilities
10. Express procedures that are clear and concise
11. Facilitate exercises to practice the operational procedures defined in the emergency response plan in a real life environment

Common conditions recommendations

1. Availability of resources

Humans (labour) – skills/competence

- The operational procedures should be defined by specialized personnel within the responsible mobility agency in collaboration to public emergency responders (civil defence, police, etc.)
- The procedures should also identify the emergency response team if not identified elsewhere

Budget:

- Budget planning should account for the required time in order to permit the definition, the appraisal and testing of the operational procedures

Data & Algorithm:

- Define KPIs to assess the efficiency in case of management of special events
- Analyse statistical data from previous special events and build assessment and predictive models
- Use official and standardized formats to describe the emergency response procedures and test them where applicable by running demonstrations in the addressed urban area
- The operational procedures should be defined in compliance to existing traffic regulations (LTZ, preferential lanes, way of routes)

2. Training and experience
   - The operational procedures should be subject of training and feedback should be collected during training phase from the involved responders

3. Quality of communication
   - Test the different communication channels (VMS, mobile APPs, web-based information, media) and tools in order to guarantee their proper use for warning users to take protective actions and provide them with information related to the operational procedures. The communications capabilities also enable members of the emergency response team to communicate with each other and with users
   - Ensure coherence among different communication channels
   - Estimates of traffic capabilities, routes available for use, and route closures will be made available to state government for public information, through all available means, real time

4. Human Computer Interaction and operational support
   - The interfaces of the Traffic Management Centre should allow monitoring the whole involved urban area in terms of real time data. The Traffic Management Centre should also allow the operator to simulate the impact of the disaster on the road network. The HMI should also permit the interaction with the Traffic Strategy Actuators for the field implementation of the mitigation strategies

5. Availability of procedures and plans
   - This includes the availability of communication channels and precise clear phrasing within the operational procedures

6. Conditions of work
   - N/A

7. Number of goals and conflict resolution
   - The operational procedures should have a well-defined target in relation to the addressed urban area and personnel

- The operational procedures should provide specific information for special categories of users (e.g. special categories of users should be addressed when describing SOP: impaired people, elder, children, ecc.)

8. Available time and time pressure
   - The SOP for the emergency management in the UTS should be specific, clear and succinct

9. Circadian rhythm and stress
   - N/A

10. Team collaboration quality
    - Roles should be clearly identified both within the responsible mobility agency and among mobility related organizations and responder organizations when defining procedures in order to enable high quality team collaboration

11. Quality and support of the organization
    - The organization should support the financial aspects in relation to operational procedures definition, training and testing

Interdependencies recommendations

Risk assessment

- Risk assessment provides the factual basis for activities proposed in the strategy portion of a hazard mitigation plan. An effective risk assessment informs proposed actions by focusing attention and resources on the greatest risks. The four basic components of a risk assessment are: 1) hazard identification, 2) profiling of hazard events, 3) inventory of assets, and 4) estimation of potential human and economic losses based on the exposure and vulnerability of people, buildings, and infrastructure.
- The risk assessment should provide the basis for procedures development and should follow a standard (e.g. OSHAS); nevertheless in case of missing or incomplete risk-assessment the process of developing procedures should overcome to this in Step 2. The process should be also continuously updated and self-learning.

Operation plan

- The Operational Plan does present highly detailed information specifically to direct people to perform the day-to-day tasks required in the running the organisation. Organisation management and staff should frequently refer to the operational plan in carrying out their everyday work in order to ensure the desired level of service of the transportation network for all transportation modes.
- Procedural documents, the SOP, describe how to accomplish specific activities needed to finish a task or achieve a goal or objective. Put simply, Operational Plans describe the “what” and SOP describe the “how.” The SOP should grow naturally out of the responsibilities identified and described in the Operational plans
- The operational plan should foresee alternatives in case of collapse of the transportation means in certain zones of the controlled urban area

Safety regulation

- All defined procedures should follow standard guidelines in relation to existing safety and health regulations (e.g., OSHAS 18001)

Limitations

- Limitations in relation to SOP might be related to their complexity and non-applicability due to the damage of infrastructure itself.
- SOP might require a very good knowledge for a correct field application

Examples

- Transportation has a vital role in Disaster Management as it can minimize the time span of all the Emergency Support Functions. PEN INDIA TECHNOCRATS has developed the SOP for ESF 'TRANSPORTATION' by integrating the role of Primary & Support agencies with reference & context of HPC Report, statutory documents & Guidelines of Disaster Management Cell – UPAAM & exploring the subject with our experience. aim & objective to have least Response Time in case of emergencies involving from a transportation point of view.

4.1.8 Manage human resources

Background facts

In the frame of UTS, managing human resources is a function that regards every organisation involved in providing transport service, managing and regulating urban traffic (private and public), providing support and emergency services in critical scenarios, as well as offering other services, such as dissemination and update of related information.

Strategic workforce planning should address three critical needs:

(1) aligning an organization's human capital program with its current and emerging mission and programmatic goals;

(2) adopting long-term strategies for acquiring, developing, and retaining competencies and expertise to achieve programmatic goals;

(3) previewing the continuous update of all actors' competencies, skills and risk awareness, according to technological changes in the Transport sector, such as the ones related to the implementation of different ITS with the aim of promoting the transport efficiency, safety and security together with a clear and effective protection of the environment.

HR function develops effective human capital management strategies to ensure the organization is able to recruit, select, develop, train, and manage a high-quality, productive workforce in accordance with merit system principles. This function includes:

- developing human resources and human capital strategies and plans;
- establishing human resources policy and practices;
- managing current and future workforce competencies;
- developing workforce and succession plans;
- managing the human resources budget;
- providing human resources and human capital consultative support;
- measuring and improving human resources performance;
- determining, implementing, monitoring, reviewing and evaluating human resource management strategies, policies and plans to meet business needs;
- advising and assisting other managers in applying sound recruitment and selection practices, as well as appropriate induction, training and development programs;
- developing and implementing performance management systems to plan, appraise and improve individual and team performance;
- representing the organisation in negotiations with unions and employees to determine remuneration and other conditions of employment;
- developing and implementing occupational health and safety programs and equal employment opportunity programs, and ensuring compliance with related statutory requirements;

- overseeing the application of redundancy and other employee retrenchment policies;
- monitoring employment costs and productivity levels;
- training and advising other managers in personnel and workplace relations matters.

Anyhow there are several drawbacks that may increase the function variability up to an undesired level, such as:

- Personnel
  - Different ranks
  - Different experience levels
  - Different skills and competencies
- No standard approaches for HRM systems
- The lack of data
- Non-harmonized processes
- Classification problems
- Insufficient synchronization
- Skill mismatch
- Lack of common language based on occupational areas
- An organization that supports HCM provides employees with clearly defined and consistently communicated performance expectations. Managers are responsible for rating, rewarding and holding employees accountable for achieving specific business goals, creating innovation and supporting continuous improvement.
- Users and their great variety introduce a source of variability, which together with the transport dynamics, increases complexity and uncertainty.
- The presence of users in critical scenarios requires special training and promptness of emergency actors.
- Usually, the selection is up to a hiring manager, who often has functional and departmental skills in his area, but lacks of human resources management experteees.

General recommendation

Human resource availability needs to be secured for both daily activities and during emergency. A dedicated buffer capacity (e.g. stand-by staff) should be defined in advance and tailored according to emergency scenarios.
A Human Resource Management system/Human Capital Management System should be implemented.
The skills and expertise that staff develops over years in performing highly complex processes, constitute a critical operational asset. The retirement, dismissal, leave or absence of specialised staff should be anticipated and accounted for, namely by provided a sufficient overlap period with replacement staff to support suitable on-job training.
The 10 human capital components that a UTS should develop are:

1. Organizational design
2. Leadership
3. Culture
4. Engagement & awareness
5. Learning & adapting

6. System thinking
7. Safety and Security behaviour
8. People analytics
9. Workforce management
10. HR Manager skills

Experienced recruiters should take responsibility for preparing managers and members of the recruitment panel for interviews with candidates. Recruiters from the human resources department have the expertise to provide the kind of guidance that hiring managers need to hone their ability to make informed recruitment decisions.

HR in UTS should manage employee stress and burnout threats caused by internal (e.g. work conditions, task assignments, human relationship (e.g. mobbing)) and external factors (e.g. status, mourning) taking into account both psychological and physiological health. Every stress and burnout threat detected by medical controls should be communicated to the HR in due time in order to allow for the application of specific countermeasures (e.g. shifts rescheduling, vacations, different tasks assignment) to mitigate the risk of errors/failures, of self-harm actions (e.g. Germanwings Flight 9525 crash) while maintaining the normal operation performance. To this end a strong connection (e.g. procedure) between medical services and Transport HR management should be established, balancing the privacy and security issues.

Common Conditions recommendations

1. Availability of resources

HR Management should guarantee

- Historic and updated performance data and its analysis in view of current operational conditions and the demands these may impose.

Human Resources Management System/Human Capital Management ICT system (HRMS/HCM)

- Use an auditable real-time HRMS/HCM system to maintain employee status, role information and system for collecting and analysing hiring data. In the back office, HCM is either a component of an enterprise resource planning (ERP) system or a separate suite that is typically integrated with the ERP. HCM is a software tool for both employee records and talent management processes. The records component provides managers with the information they need to make decisions that are based on data. Talent management can include dedicated modules for recruitment, performance management, learning, and compensation management, and other applications related to attracting, developing and retaining employees.

- HRMS/HCM software streamlines and automates many of the day-to-day record-keeping processes and provides a framework for HR staff to manage benefits administration and payroll, map out succession planning and document such things as personnel actions and compliance with industry and/or government regulations. While now nearly synonymous with HRMS, HCM systems usually go beyond

- HRMS/HCM should contain information about knowledge, skills and abilities (KSAs), interests General Work Activities, (GWAs) and work context.

Financial plan

- Recruitment activities should be driven by the financial plan as well as strategic plan. According to this it is recommended to gather labour market intelligence coherently and consistently in order to quantify the skill requirements and its market value.

2. Training and experience

- As the development of employees and the continuous improvement in corporate performance are strictly interrelated, the organization's main objective is to increase the value of internal human resources through targeted programs. Training and knowledge management, in fact, guarantee continuous improvement by developing cultural competencies, reinforcing the organization identity and spreading its values.

- Compensation and Benefits management skill: Being able to keep compensation and benefit packages attractive over time is essential to retaining top talent.

- Recruitment and Hiring skill: A complementary set of decision-making skills, avoid biases skill and strong interpersonal skills are necessary skills for an effective hiring manager.

- Performance/Employee Evaluation skill: Developing a successful and meaningful performance evaluation process takes time and innovation. Human resource managers who actively develop programs that engage the employee in an on-going professional development process help building a dynamic workforce. In order to frame performance evaluations positively, human resource managers need to develop versatile communication skills.

- Training and Staff Development skill: In the role of a training and staff development leader, human resource managers have an opportunity to develop a wide range of important skills, particularly in what concerns the relevant selection criteria and the identification of training needs, as well as leadership.

- Adaptation and flexibility skill; HR managers must be well prepared to respond to rapidly changing workforce dynamics. With three generations in the modern workplace, managers need to be equipped with sound knowledge as well as a wide repertoire of skills to address the four top competency areas in human resources environments across all industries. Building effective communication skills, organizing complex corporate policies, preparing employee programs, and demonstrating creative problem-solving and conflict resolution ability, are among the top skills needed to be successful in a human resource management position.

3. Quality of communication

- Encouraging internal communication: To keep employees constantly informed of the organization activities and business development, a wide range of corporate communication means are in place (intranet, internal corporate magazines, etc.). Moreover, in order to promote an open and transparent organisational culture, the organisation should encourage continuous dialogue between managers and employees both informally, using an approach of listening, and through structured feedback meetings, primarily focussing on individual performance and professional growth.

4. Human Computer Interaction and operational support

- Integrate HRM System with IT Physical Security Access control system to ensure real time employees' access management (e.g. terminated employees are consistently denied access, throughout the organisation).

5. Availability of procedures and plans

- Adopt a Consistent Skill and Competencies Categorisation and Experience Levels – The aim is to develop a table-based structure on occupational areas, such as Administration, Intelligence, Operations, Logistics, etc. that categorise the manpower skills and associated competencies required. The Technical Team must use standardized Occupational Area Codes as the starting point to develop this catalogue.

- Catalogue of Current HRM Models, Methods, and Methodologies: The technical team should develop a catalogue that delineates the various models with their associated methods and methodologies that are currently used in their HRM. The group shall be responsible for categorising models, methods and methodologies.

- Minimize downside to employees for participation, such as demotion, loss of employment or privacy.

- Include coordinated policy to appropriately scale employee access during high-risk periods, minimizing risk of sabotage.

- Use (available/CERT) research findings to develop a process and a set of policies focused to protect assets and operations while dealing with a potential hostile insider.

6. Conditions of work

- HR management, having in mind health and safety concerns regarding every employee, has the responsibility of defining working conditions in terms of tasks, workstations, work schedules, shift work, workloads and every individual or collective protection against heavy work and/or risky conditions.

- Establish an all-party consent statute regarding free use of internet and any technological tools (e.g. email, Skype, etc.), particularly in what concerns critical matters regarding security issues and knowledge protection.

7. Number of goals and conflict resolution

- Motivational approach – involvement of human resources through inducements and contribution strategy. Inducements are desired aspects of participation. For instance, inducements of working for a company are a suitable salary along with insurance options. Contribution on the other hand has a negative utility form the HR perspective, but is the requirements for participation. Inducements and contributions of a position in a system, should be contracted each other since human resource may not adhere to contribution.

- Ensuring equal opportunities Career opportunity and career progression are managed without discrimination while respecting and enhancing diversity. Considering skills as an asset to be developed and shared, organizations should be committed in helping people adapt in real time to change in an increasingly complex world.

- Attention to the Work/Life Balance - In order to promote respect for all employees as individuals, organization should promote care and attention to employees by supporting them in achieving a sustainable work/life balance.

8 Available time and time pressure

- HR are the most effective means of coping with operational variability and the time pressure that often results from such variability. This should be taken into account so that working conditions should be designed in such a way that impacts of variability and time pressure are minimised and do not compromise inherent human adaptive capacities. However, it should be highlighted that time pressure represents a source of stress to employees, favouring the occurrence of errors and hasty decisions that compromise safety and security.

9 Circadian rhythm and stress

- As circadian rhythm asynchrony has important effects in performance and lead to decrements in vigilance, HR should preview job schedules, as well as individual rest and sleeping times that favour the desire performance.

- Research has shown that the direct effects of various stressors (including fatigue) can be modulated by individual differences and psychological processes (i.e., motivation, effort, etc.), which favour the adaptation process. This requires from HR management a good leadership encouraging employees and favouring their risk perception, decision-making and performance.

- High workload and time pressure result in an increase in subjective stress level being both sources of fatigue, as well as errors and hasty reactions. Thus, HR should manage job allocation ensuring acceptable workloads and thus, creating conditions for the best performance.

- Other factors of stress and burnout threats caused by internal human relationship (e.g. mobbing) and external factors (e.g. family status, mourning) should be managed taking into account both psychological and physiological health.

- All employees should be assigned with an active role in contributing to their own development and the success of the organisation or system. In order to minimise the risk of work-related stress, HR management should:

    - Ensure good communication with colleagues and their manager;

    - Support colleagues by providing appropriate information and by sharing knowledge and resources where appropriate;

    - Engage in discussion about their performance and act on feedback;

    - Raise issues of concern at an early stage and seek constructive solutions;

    - Make use of the support and training resources available;

    - Ensure that bullying and harassment is not tolerated;

      Comply with organization employment policies and policies on health, safety and security;
    - Seek appropriate advice and support at an early stage if difficulties arise.

10. Team collaboration quality

In order to ensure a good collaboration within each team, HRM should:

- Define HRM polices to be integrated with business strategies.

- Develop HRM policies in coordination with internal legal, security and human resources team managers and, where applicable, with the resource manager for job specific policies.

- Build a cross-departmental insider threat approach and response team, to include: IT, Physical Security, Legal, and Human Resources.

- Coordinate employee hiring, screening, and termination policies with legal team and asset owners or risk managers to ensure legal team understanding of the potential costs of insider threats.

- Coordinate legal perspective with asset owners and risk managers to develop clear understanding of insider threat consequences and costs.

11. Quality and support of the organization

Ensuring a good support from the organisation is an important condition for the best performance and requires to:

- Establish a strong Employee Assistance Program to help employees identify themselves and peers for assistance during high-risk periods of difficulty.
- Develop documents to establish accountability, e.g., employee's annual ethics certification, confidentiality agreements, supplier security requirements for contracts.
- Focus on Talent Management and Succession Planning: Talent Management is a key lever in achieving the organisation's talent development goals and releasing the potential of people. Therefore, attracting, retaining and developing leaders which can face future challenges, thus giving priority to the development of internal resources, is crucial to solid succession planning. A consistent, global approach that encourages cross-functional and cross-sector mobility (even across geographies) allows capitalisation of the talent management process which constitutes an essential competitive advantage. This process ensures that the leadership pipeline is continuously fed at all levels of the organization.

Interdependencies recommendations

Emergency HR request

- Preparing for emergencies involves evaluating risks, determining the legal and regulatory players, and the role of unions, vendors, and contractors, especially on a multi-employer site. Moreover, the cooperation with safety, engineering, risk management and operations to both address contributing factors and to implement best practices is recommended.
- Establishing an institutionalised connection with emergency responders in order to create reliable communication channels. Such collaboration includes the participation in the investigation and root cause analysis, the contribution to define training requirements, etc.
- Managing pay and benefits for employees engaged in emergency respond and extra time work requested by the emergency.
- Creating and maintaining up to date an emergency plan for mobilizing the right human resources in due time. In particular, it is necessary to establish a reliable engagement process with different level of employee readiness.

Operation HR plan

- Involve top management employees and other stakeholders in developing, communicating, and implementing the strategic workforce plan.
- Determine the critical skills and competencies that will be needed to achieve current and future programmatic results;
- Develop strategies that are tailored to address gaps in number, deployment, and alignment of human capital approaches, for enabling and sustaining the contributions of all critical skills and competencies.

Limitations

- Limitations depend on the skills of the UTS related staff, budget and interconnections with monitoring staff and training.

Examples

Quito, Ecuador establishing a municipal risk management system with the appropriate human, technical and financial resources and capacities.

- Quito city in Ecuador established a municipal risk management system by carrying out policies in an integrated manner to security, addressing situational risks, road safety and risks to natural and technological hazards. More information at: http://www.quito.gov.ec

4.1.9 Manage ICT resources

Background facts

Some of the most active areas of ICT deployment have been the urban transportation systems. The ICT has proven to play a crucial role for the efficient management and optimization of urban transport operation especially in case of emergency or disaster. Technological advances in telecommunications and information technology, coupled with ultramodern/state-of-the-art microchip, RFID (Radio Frequency Identification), and inexpensive intelligent beacon sensing technologies, have enhanced the technical capabilities that enable the implementation of intelligent transportation systems (ITS). Although ITS may refer to all modes of transport, EU Directive 2010/40/EU (7 July 2010) defines ITS as systems in which information and communication technologies are applied in the field of road transport, including infrastructure, vehicles and users, and in traffic management and mobility management, as well as for interfaces with other modes of transport.

Intelligent Transportation Systems (ITS) are widely recognized as an efficient and effective way to ease traffic congestion in many large cities by controlling traffic to realize the optimal use of existing road capacity. Intelligent Transportation Systems (ITS) are actually advanced applications which aim to provide innovative services related to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks. Sensing systems for intelligent transportation comprise vehicle-based and infrastructure-based networked systems. Advanced applications may deal with: inductive loop detection, video vehicle detection, Bluetooth detection, audio detection, information fusion from multiple traffic sensing modalities etc. Some example systems include the following:

- Emergency vehicle notification systems
- Collision avoidance systems
- Cooperative systems in road traffic
- Traffic detection systems
- Traffic monitoring systems
- Video surveillance systems

Intelligent transport systems vary in technologies applied, from basic management systems (such as car navigation, traffic signal control systems, container management systems, variable message signs, automatic number plate recognition or speed cameras) to monitor applications (such as security CCTV systems). In addition, to more advanced applications that integrate live data and feedback from a number of other sources (such as parking guidance and information systems, weather information, bridge decision systems). The new embedded system platforms allow more sophisticated software applications to be implemented, including model-based process control, artificial intelligence, and ubiquitous computing. Additionally, predictive techniques are being developed to allow advanced modelling and comparison with historical baseline data.

A very important role in the attempts to improve highway safety, operations and use of existing facilities plays the Variable or Changeable Message Signs (VMS). VMS are traffic control devices, which are used for traffic warning, regulation, routing and management, and are intended to affect the behaviour of drivers by providing real-time or predicted information. Examples of such information include travel times between known destinations, traffic congestion, construction notices, special event notice and motorist instructions, maintenance operations schedule, pending sever weather announcement, incident notification. In urban areas, VMS are used within parking guidance and information systems to guide drivers to available car parking spaces. They may also ask vehicles to take alternative routes, limit travel speed, warn of duration and location of the incidents or just inform of the traffic conditions. Most manufacturers produce VMS which comply with the National Transportation Communications for Intelligent Transportation System Protocol (NTCIP), which allows the them to be integrated with an intelligent transportation system. The NTCIP is a family of standards designed to achieve interoperability and interchangeability between computers and electronic traffic control equipment from different manufacturers. VMS should also comply with the corresponding established national and international standards.

General recommendation

- Deliver and maintain a well-established plan dealing with all the possible difficulties and taking into account all ICT resources needs in UTS
- Develop effective ways to maintain information and communication systems among transport system managers, staff and users under normal and extreme conditions.
- Address urban transportation needs through innovative applications of broadband, mobility and cloud services, such as:
  - Smart vehicles and infrastructure (e.g. vehicles and roadways that communicate with one another through networks leading to safer and more efficient travel and transportation, driverless vehicles)
  - Transportation services
  - Multimodal transportation (making it possible for individual travellers to optimize their journey through the city across multiple modes of public and private transportation)
  - Redefined city spaces (reshaping city spaces, reducing distinctions between work/shopping/living areas, and transforming the city itself into a service)
- Utilize ICT for transport management practices
  - Adopt Intelligent Transportation Systems, such as electronic fare and road user charging systems, transport control centres, and real-time user information, when applicable.
  - Provide access to public transit system information, including service changes, schedules and maps.
  - Provide alerts for outages, including mobile devices.
  - Develop online or mobile device payment access for public transportation, tolls, parking and metro congestion management systems.
- Disasters such as hurricanes, fires and risks of explosions or toxic chemical releases sometimes require major evacuations. Such events require effective planning, communications and management, activities that are important at any time, but become even more critical during major emergencies. Moreover, systems that would facilitate the coordination of the evacuation procedure and the communication between the responsible authorities and the citizens may play an important role.
- Smart city projects need to leverage IoT Technologies and data to facilitate and support real-time Urban Transport Information systems.

Traffic lights, traffic control sensors and video-surveillance, vehicle management systems and communication channels need to be in deep integration to allow both resilience and risk management.

Common Conditions recommendations

1. Availability of resources

Supply resources:

- A variety of traffic monitoring and surveillance systems should be in place in order to provide real-time information on special events, thus improving route selection, reducing travel time, mitigating the severity and duration of incidents and improving the performance of the transportation network.
- Travel time and speed data should be available for vehicles travelling along streets, highways, motorways (freeways), and other transport routes. Methods used to obtain the raw data may include:
  - Triangulation method
  - Vehicle re-identification
  - GPS based methods
  - Smartphone-based rich monitoring
- A message displayed on a panel in order to be complete should include:

    - A problem statement indicating incident, roadwork, stalled vehicle etc.
    - A location statement indicating where the incident is located
    - An effect statement indicating lane closure, delay, etc. and
    - An action statement giving suggestions about what to do.
- Develop ways to prioritize transport system resources when necessary. For example, design systems to allow emergency, service and freight vehicles priority over general traffic.
- Design critical components of the transportation system to be fail-safe, self-correcting, repairable, redundant and autonomous. For example, where possible, use roundabouts instead of traffic signals, since they function without electricity.
- Encourage efficient use of resources, including energy conservation.
- Distribute emergency evacuation information to at-risk populations and all officials, including instructions on pickup locations and routing guidance. This information should be distributed regularly, not just during major emergencies.
- For the provision of passenger information (static or real time) consider:
    - Data availability: Information can only be provided where it is available, and collecting information can be resource intensive. In addition, there may be difficulties in one organization (say an operator) allowing other organizations to access its information.
    - Data accuracy: Collecting information is error-prone, particularly when it is passed between systems manually. Moreover, prediction algorithms are not perfect, and real-time announcements may be in error for this reason.
    - Getting information to the passenger: A variety of dissemination mechanisms may be used, but it is not always easy to ensure that the correct information reaches the passenger when it is most needed. Apart from the obvious economic considerations, information overload must be avoided.
    - Latency or Response time: Information provision must react quickly to a passenger request or a real-world update. For example, there is little point in announcing a service three minutes after it has departed.

2. Training and experience
- Staff cross training to perform critical management and repair services.
- Training of technical experts in order to be able to manage, update, and repair in time the ICT resources during an emergency.
- Regular test exercises for the technical experts.
- Educating and creating awareness in the population so that they may respond with the appropriate action.

3. Quality of communication
- Ensure quality communication through ICT with residents and travellers under emergency conditions in order to avoid panic movements and actions.
- Consider the use of VANETs (Vehicular Ad hoc Networks) as a key component of ITS for the spontaneous creation of a wireless network for data exchange.
- Ensure information sharing (TV, mobile TV, radio, data broadcasting, internet etc.).
- Revise regularly technical standards for important communications.

4. Human Computer Interaction and operational support.
- The system should be able to identify and contact vulnerable people, provide individualized directions for their care and evacuation, and establish a chain of responsibility for caregivers
- User-friendly platform for the technical experts and the travellers/passengers.

- Operational platform which will ensure the communication of travellers/passengers and rescuers in emergencies.

5. Availability of procedures and plans

- A plan for an efficient transportation system needs to be prepared, human resources need to be developed and organizations strengthened for proper infrastructure planning and maintenance.
- Institutional arrangements should be made to allow transportation operators to manage, their infrastructure assets.
- Maintain contingency plans to allocate fuel and other resources in emergencies.
- Revise technical standards on measures for countering congestion
- Transport Planning for Disaster Management
    - Evacuation Route Design on Road Networks
        - Existing Network Design for Evacuation
        - Communication Network Design
        - Public Transportation Network Design
        - Social Organization Network Design
        - Multi Agent Transport Simulation
        - Assessment of Vulnerability and Criticality
    - Information Provision Strategy for Dispersion
        - Alternative shortest path provision
        - Space Syntax Technique (to find alternative shortest path)
        - Dynamic Shortest Path Calculation
        - Short-term Travel Time Prediction
    - Furniture Layout Design on Transit Stations
        - Pedestrian Movement Modelling
        - Different Layout Design for the Station Furniture
        - Pedestrian Simulation on Designs
        - Evaluation of Design

6. Conditions of work

- Friendly working environment
- ICT infrastructure should be accessible for all

7. Number of goals and conflict resolution

- The ICT management plan should set goals and objectives for the UTS that are Specific, Measurable, Assignable Realistic, and Time-related (S.M.A.R.T).
- The roles and responsibilities of each team member should be clearly defined and not overlapped in order to avoid conflicts.
- The number and scale of tasks/responsibilities assigned to each person should be reasonable (and not excessive) based on the ICT management plan and the corresponding timetable.
- Specific rules/principles should be defined in conjunction with a hierarchical working structure in order to address possible conflicts.

8. Available time and time pressure

- Prioritize evacuations based on factors such as geographic location (evacuate the highest risk areas first), and individual need and ability.
- Planning milestones and deadlines should integrate degrees of flexibility to cope with planning quality requirements

- Timely disaster warning to mitigate negative impacts. Such warnings must be unambiguous, communicate the risks succinctly and provide necessary guidance
- In emergencies, the importance of the ICT support is of vital significance especially in the first 72 hours referred as "Golden 72 Hours". Moreover, during this period any damages in the communication infrastructure have to be repaired.

9. Circadian rhythm and stress

- A plan should be defined for managing the risk of operators fatigue and the disruption of the circadian rhythm in safety-sensitive businesses (e.g. a Fatigue Risk Management System (FRMS) in order to reduce the possibility of critical human errors.
- The management of ICT resources should be such that it reduces sources of stress for ICT operators.
- In case of critical operations carried out by only one person, a second person should be in stand-by.
- Staff should be adequately trained to manage stress and act efficiently under pressure avoiding panic.
- ICT resources should include functions to be executed in an automatic manner with threat and risk alerts prior to events in order to avail a safety response time. Automated emergency response alerts should be activated when necessary.

10. Team collaboration quality

- All involved stakeholders (transport authorities, traffic police, police and station security agencies and staff, ICT staff, transport operator managers, hub and terminal managers etc.) should collaborate effectively.
- Adhere to the facets of teamwork quality (communication, coordination, balance of member contributions, mutual support, effort, and cohesion).
- Utilize suitable team collaboration tools to ensure effectiveness.
- Establish tools/methods for evaluating often team collaboration quality (e.g. Col-MM).
- Continuously train the team to retain the quality of the team’s collaboration in high level.

11. Quality and support of the organization

- Improve the efficiency of government operations
- Perform external and internal audits to ensure the safety/adequacy of ICT resources.
- Perform proper testing and vulnerability assessment activities need to be scheduled periodically, depending on the variability of the ICT asset.

Interdependencies recommendations

- In order to monitor the operation of the UTS, the necessary ICT equipment and services have to be set/installed, including sensing infrastructure, emergency vehicle notification systems, collision avoidance systems, traffic detection and monitoring systems, video surveillance systems etc.
- The definition of the procedures has to be performed considering the requirements of the ICT infrastructure.
- The coordination of emergency actions is based on the quality and the readiness of the ICT resources.
- Supply resources availability should be monitored in order to ensure ICT proper operation. In case of a detected problem, immediate action should be taken based on the backup plan in order to reduce any negative consequences in urban transport.
- User generated feedback should be considered in a timely manner in order to ensure proper and efficient UTS operation.

Limitations

- Myopic preference for a low-cost ITS option without a clear long-term strategy may limit the scope for future system expansion and compatibility with other traffic systems.
- ICT cannot eliminate possible economic loss and damage to UTS property in case of a disastrous event but it can mitigate its negative impacts.
- Lack of adequate financial support.
- Limitations set by transportation channels.
- Limitations set by governments, legislation, cyber security regulations and international transportation standards.

Examples

- eCall – An Emergency vehicle notification system: eCall is a European initiative intended to bring rapid assistance to motorists involved in a collision anywhere in the European Union. The in-vehicle eCall is generated either manually by the vehicle occupants or automatically via activation of in-vehicle sensors after an accident.
- Intelligent disaster management system based on cloud-enabled vehicular networks proposed by Alazawi et al. Alazawi et al. propose an intelligent disaster management system which is able to gather information from multiple sources and locations, including from the point of incident, and is able to make effective strategies and decisions, as well as to propagate the information to vehicles and other nodes in real-time.
- MATSim - Multi-Agent Transport Simulation: MATSim is an open-source framework to implement large-scale agent-based transport simulations.

CRAMSS - CRAMSS (Collaborative Resilience Assessment and Management Support System) aims 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 displays information from different sources or independently running web-applications, together with the results of the decision support (e.g. evacuation planning)

4.1.10 Maintain UTS physical/cyber infrastructure

Background facts

UTS infrastructures are critical for any city or metropolitan or regional area. Such infrastructures need to be maintained and managed in order to guarantee a safe service level during regular operation and, moreover, in order to be able to adapt them in case of emergency.

UTS are deeply interconnected with – and are part of - the city CIs.

The need for maintenance stems from several causes: security reasons, when a malfunction or failure may endanger the safety of persons; importance of maintaining the CI service; requirement to maintain in good conditions certain parts of the CI. Despite technological advancements and the generalization of leanness principles, it is still possible to grossly divide maintenance in ordinary and extraordinary.

Ordinary maintenance for UTS is mainly related to the need to make the different subsystems well interoperable and well monitored during regular operation.

Extraordinary maintenance for UTS – adapted to the resilience concept – can be related to the capability to adapt and configure the existing assets in order to ensure a "best-effort" operation of the urban transport infrastructure for the safeguard of population and evacuation procedures, during emergencies.

This guideline analyses the possible aspects and issues that may affect the Physical and Cyber UTS infrastructure functionality

General recommendations

This guideline reminds best practices and references for coordinating the maintenance service to keep UTS subsystems, equipment, hardware assets, ICT and other related infrastructure facilities (e.g. smart city assets for mobility, energy, telecommunications) in operation, and operating efficiently and safely.

Physical infrastructures of UTS can be divided into these main areas:

- Sensors/hardware positioned on the ground: surveillance and traffic monitoring video cameras, sensors, telematics gates controlling entrance/exits to/from specific areas/roads
- On-board hardware: personal devices of workers used as moving sensors, on-board control units, hardware necessary to make the vehicle work and connect to the transport control centre
- Hardware of the Transport Control Centre
- Transport vehicles
- Enabling ground infrastructures (e.g. tram line pathway).

Cyber infrastructures of UTS are mainly related to software used to configure, control, manage and tune the different hardware assets and the services related to the UTS physical hardware infrastructures. These may include:

- Automatic Vehicle Management systems
- Communication networks
- Traffic monitoring tools
- Traffic management and configuration tools
- Digital communication channels and displays on-board and on public spaces (roads, bridges, water canals).

Each of the above assets should be properly maintained with suitable contracts where service-level agreements will determine time of intervention, recovery time, and service and business continuity depending on the relevance of the asset and on the risk assessment performed on the UTS.

To contribute to the resilience of the system, maintenance activities need to be organized to satisfy the following criteria:

- Verify the presence of requirements relevant to maintenance in contract/procurement documents
- The allocation of resources to maintenance is coherent with the size of the infrastructure and maintenance policy
- Maintenance activities are revised periodically to take into account new discovered events and requirements
- To be more responsive to unforeseen issues, adopt from the beginning (resilient by design) prognostic models in order to perform "predictive maintenance"

Common Conditions Recommendation

1. Availability of resources

Humans (labour) – skills/competence

- Each UTS infrastructure can be seen as a complex system: accumulation of competence about each system is as important as knowledge of components and regulations.

- A continuous exchange of information between maintenance personnel and the other infrastructure's stakeholders, including the management, should be put in place in order to increase the level of awareness on the real status of the infrastructure.

- UTS assets are usually composed of two main types of co-existing assets:

  - Legacy and non-standard hardware or systems (such as obsolete on-board control systems on the vehicle).
  - New and more recent sensors and monitoring assets and hardware making it possible to control operation and produce new services to users of the transport system.

Skills on both the asset types are very difficult to be maintained and managed simultaneously, because traditional transport authorities have skills that are historically based on the old "analog" assets, while recent companies producing new services such as IoT technologies for transport management are not skilled on traditional transport asset maintenance.

Budget:

- Adequate financial resources are needed for regular maintenance and there must be reserves for extraordinary interventions. Maintenance costs must be considered an essential, unavoidable part of the budget.

- A trade-off between maintaining obsolete assets and updating those assets with a replacement must be done periodically, in association with the strategy definitions of the Organization.

Data & Algorithm:

- UTS is managed, controlled and used through data exchange processes.

- Typically, existing UTS assets are "legacy" and "vendor-locked-in" which on the data side is translated into the existence of many "black-box" whose data are not easily accessible by other system.

- Therefore, high integration costs are common when dealing with obsolete transport management systems. However, when activating new contracts, it is mandatory to introduce new requirements to have standardized access to structured data.

- UTS management algorithms are implemented into the business logic of the different management systems.

- In order to set up higher level resilience strategies the Intelligence Transport System should accept Machine 2 machine controls from other system, for example to activate other configurations managing degraded conditions.

- In order to introduce the concept of Predictive Maintenance it is desirable the usage of Big Data/Machine Learning technologies.

2. Training and experience

- The increasing importance given by public authorities to quality and safety, while meeting sustainability targets, has upgraded the attention paid to effective maintenance and asset management, which is considered critical by all stakeholders.

- Efficient maintenance management training enhances the capacity of human capital to contribute towards the enterprise strategic goal of rationalizing asset usage and increase the safety.

- More efficient training can be achieved through on-the-job training (OJT), even with the help of augmented reality (AR) tools, to improve training rhythm and reduce training costs.

- In particular, within UTS, it is usual to have maintenance personnel on the field with uncomfortable operation spaces, hard access to data and technical data of the asset, in which case the use of mobile and portable technologies can help having more effective maintenance operation. These new tools require adequate trained personnel.

3. Quality of communication

- Guarantee a structured and validated flow of information among maintenance personnel, decision makers and citizens (the final users of the infrastructure) aiming at increasing the awareness level of the real status of the infrastructure.

- Guarantee the accuracy and understandability of the communication through standardized communication tools, protocols and languages.

4. Human Computer Interaction and operational support

- Utilization of maintenance software tools for real time and offline data analysis and maintenance focused intervention plans.

- Utilization of software tools implementing standardized and local maintenance procedures and practices permitting operative personnel and infrastructure managers to take right decisions

5. Availability of procedures and plans

- Develop a strategy and plan for UTS infrastructure maintenance, and ensure that such plans are really shared and widely known among maintainers themselves, but also among stakeholders, controllers, experts, and even the general public, in transparency.

6. Conditions of work

- Wide, shared, agreed awareness of security and sustainability issues need to be adapted to conditions of work for maintenance of UTS assets.

- Most dangerous working conditions are those referred to maintenance of hardware and physical UTS infrastructures, while software operations are usually less critical on this aspect.

- When possible, it would be preferable to let maintenance employees' work on the UTS physical asset within their company quarters, thus allowing for better and more controlled working conditions.

- If on-the-field work is required, proper attention must be paid to security working conditions and avoiding stressful situations, for instance by documenting in advance the possible dangerous conditions.

7. Number of goals and conflict resolution

- Roles and duties of the different actors maintaining a complex physical or cyber infrastructure need to be defined and documented in order to reduce conflicts during intervention upon failure or regular ordinary maintenance operations.

- The efforts and the timing during the emergency should be reduced by being able to early detect the anomaly generating the crisis.

- The amount of data collected during standard operation to be used during the emergency should increase.

8. Available time and time pressure

- UTS maintenance personnel shall be able to help people dedicated to emergency management in a very short-time.

- Standard maintenance activity shall be carried out during normal infrastructure's operation.

- Workers need to be trained to perform rapidly during normal maintenance operation, in order to be able to solve rapidly failures during emergencies.

- An updated and continuous learning process on the maintenance guidelines related to the UTS assets will help the execution of maintenance activities during emergency in short time.

9. Circadian rhythm and stress

- To ensure that physical and cyber transport infrastructures are properly managed and well-maintained, it is important also to allow workers proper time shifts. As a matter of fact, the stress and the excess of working hours can lead to human errors in following written procedures for the infrastructure maintenance.

- More than one person should be trained to maintain each specific urban transport subsystem, in order to avoid excessive pressure and stress over the same employee.

10. Team collaboration quality

- High quality of human relations is required, in particular among technical personnel of critical infrastructure, infrastructure managers and emergency stakeholders.

- UTS assets are a typical field where multi-vendor sub-systems co-exist, therefore a proper collaboration and communication strategy need to be implemented among the different stakeholders of the maintenance of the specific asset.

11. Quality and support of the organization

- Clear decision making process and alignment of responsibility with accountability should be put in all the UTS maintenance chain.

- Maintenance organization shall be characterized by task assignments, work-flow, reporting relationships, and communication channels that link together the work of the different individuals and groups participating to the UTS maintenance.

- Any structure of the organization must allocate tasks through a division of labor and facilitate the coordination of the performance results. There is not one optimal structure that meets the needs of all circumstances. Organization structures dedicated to maintenance should be viewed as dynamic entities that continuously evolve to respond to changes in technology, processes and environment.

Interdependencies recommendation:

The current guidelines are linked to many other critical functions related to the UTS resilience:

- Strategic planning and financial budget planning is an important input to the Maintenance of Cyber and Physical UTS infrastructures.

- Such a function is related and propedeutic to the service delivery, and to the monitoring of operations and ICT subsystems.

- Human resources management and training is a critical success factor for an effective maintenance of UTS subsystems.

Limitations

- Complexity of the Physical/Cyber Infrastructure leads to parts or subsystems not properly maintained, which becomes then vulnerable in cases of failures or emergencies.

- Many of the current technologies are lacking consolidated standards and reference maintenance procedures; this can lead to vulnerabilities.

- Strength of environmental disasters may overcome the limits of tolerance to UTS failure of the asset, even if maintained.

- Communication failures among the many and heterogeneous UTS actors of the physical and cyber infrastructure maintenance may lead to cases where the single part or subsystem is well-maintained, but the system as a whole is not.

- Lack of dedicated human resources often forces the same person maintaining multiple systems, thus causing stress and error-prone activities.

- Difficulty to scale the UTS monitoring system to city level

- Difficulty to share diagnostic information between heterogeneous urban transport systems

- Difficulty to share information between systems managed by different entities/ transport authorities

Examples

Kuala Lumpur's Stormwater Management and Road Tunnel (SMART)

- Substantial investments were spent to develop Kuala Lumpur's Stormwater Management and Road Tunnel (SMART) and on maintaining flood retention ponds and main drains; for maintenance and cleansing of rivers and main drains; and for river cleansing and beautification, from both the Federal Government and City Hall. For more information about the SMART tunnel, consult pages 6-7 of: Natural

Hazards, UnNatural Disasters: The Economics of Effective Prevention (World Bank- United Nations, GFDRR, 2010). http://tinyurl.com/7aalwlj

4.2 Monitor

4.2.1 Monitor Urban Transport Safety and Security

Background facts

Safety and security issues of transport operations and service delivery include attention to maintenance problems, accidents, (non) recurrent traffic congestion, extreme weather conditions, as well as unexpected events. ICT equipment is essential in monitoring all aspects of the urban transport system and triggering and communicating safety and security alerts. Traffic Management Centers, Operation Control Centers adequately staffed and equipped, interactions and communication channels with Police, Traffic Police and Data Protection Authorities are important to perform the function.

A conceptual distinction can be made between 'safety' and 'security', whereby the former refers to accidents and diseases, while the latter refers to acts of violence. Therefore, in the UTS case safety refers to manners and actions that ensure safe movements and eliminate traffic accidents or other mobility related accidents, while security deals with the feeling of safety people have while moving (terrorism attacks, thieves at bus stops, extreme weather conditions, etc.). Therefore, monitoring safety and security in the UTS system is a necessity in terms of resilience management and sustainable movements.

At the same time, while the measures and competences to manage safety are necessary, they are insufficient to manage all the risks and realities of violence, which carry additional complexities that occur in transport hubs and terminals along with transit stops and at red signal stops. In cases of emergencies these violence attitudes tend to increase making the conditions worst. Competence and measures to reduce the risks and impacts of violence can include most safety risks but are likely to overlook some others. In short, there is considerable complementarity and overlap between both areas, but they are not identical.

Monitoring is an enterprise-wide activity that the UTS uses to "take the pulse" of its day-to-day operations and, in particular, its operational resilience management processes. Therefore, UTS authorities need to collect data related to unsecure conditions, reported violent behaviour at transport infrastructure spots and map the most secure places/routes and terminals in order to prioritize secure movements in cases of emergency.

The same data collection is needed for safe movements (roads and paths well maintained and visible etc.). All these data are input to the proper UTS monitoring system in order to be able to provide safe and secure guidance in emergency conditions. Monitoring also provides valuable information about operating conditions that could indicate the need to activate traffic police/ station security or other transport body real time involvement.

All these data enable measuring process effectiveness across resilience capabilities of the UTS. For example, through monitoring, the public transport organization that operates in the urban scale, can determine whether its resilience goals, regarding security activities taken (i.e. cameras at stops) are being met and which transit stops are secure for travellers.

General Recommendations

In order to perform an effective monitoring of safety and security, the Urban Transport System must implement transport infrastructures and processes that support and enable the monitoring needs (CCTV cameras at stations and stops and office with security staff to report and react in cases needed). This implies that this system collects, organizes, records, and makes available the necessary information in a manner that is timely and accurate and that ensures data confidentiality, integrity, and availability. Moreover, these data must be reliable and be communicated directly to response bodies (security staff, police, traffic police etc.).

Common Conditions recommendations

1. Availability of resources

The relevant resources refer to safety and security personnel (adequate number of security staff, staff that monitors real time safety and security conditions etc.), equipment (CCTV cameras at stations, stops, across the road, informative screens to aware people to pay attention for their safety and security, equipment for the monitoring centre-including alert systems etc.) budget (to buy, replace and/or maintain security equipment, to maintain road safety infrastructure, for safety and security personnel salaries etc.), processes (for safety and security facilities, safety instructions and priorities, pinning "blind spots", mapping mobility related accidents and violence disturbing movements etc.) and material (printed guidance instructions for safety and security at stops, hubs, terminals, multimedia videos with security instructions, safety materials for road infrastructure, data collected, stored and their format – videos/log files/ reports etc.).

2. Training and experience

The main activities that the staff would be required to perform regarding the monitoring safety and security process are:

- operating, monitoring, and configuring monitoring systems components
- timely respond to alerts and communicate events to security response bodies (traffic police, station security personnel, police etc.)
- supporting stakeholders in understanding and interpreting monitoring data
- securing data collection and analysis from monitoring system components
- data linkage in cases of UTS security or safety alerts- for example link the geographical data with the data from previous traffic accidents in the spot of the event and the potential risks along with the level of safety conditions and monitoring
- apply safety and security regulations in everyday practice
- filter data and develop security and safety alerts for end users (communicate the safety and security risks to travellers in order to aware them and prepare them to respond properly and safely in cases of emergency)

3. Quality of communication

- The communication of the monitoring data must follow quality standards regarding accuracy, validity, security and timeliness of data.
- As mentioned in D3.5, monitoring data can expose the organization's weaknesses and therefore must be protected from unauthorized, inappropriate access where it is stored or collected, and in transmission to users and stakeholders. In addition, the timeliness of the collected data is paramount to providing an appropriate response to events, incidents, and threats and other actions the organization may take for improving its safety and security operations. Moreover, as this process includes also monitoring of people, personal data should be carefully treated, according to existing standards and regulations. The issues of cyber security should be treated according to existing recommendations.
- Moreover, the quality of communicating safety and security issues to the public should be properly selected in order to avoid panic movements and actions. It is important to keep the users' perceived level of safety and security in a tolerance level, where they are able to continue their movements without feeling threatened in a way that leads to panic reactions.

4. Human Computer Interaction and operational support.

This part has mostly to do with the personnel responsible for handling the monitoring equipment, that need to be properly skilled and specialised (through adequate training and previous experience) to handle safety and security data, analyse and combine them if needed to understand and communicate information and alerts.

5. Availability of procedures and plans

The procedures and plans for safety and security monitoring should be clearly defined in the Safety and Security Urban Transport Monitoring plan and should comply with the monitoring requirements as defined by the needs of the addressed stakeholders. Each involved party should be aware of their responsibilities and recommended actions in normal routine or in case of an emergency. The goal of establishing specific procedures is that the performance of the task is realised in a well-organised and effective manner, so as to provide timely and accurate information of the safety and security status of transport infrastructure and general public movements. Such processes may involve the collection, storage and generally the management of data, as well as monitoring operation procedures (controls, reports, etc.). The procedures should be prioritized in order to secure travellers, with specific instructions for kids, the elderly, reduced mobility persons along with transport infrastructure prioritizing protection guidance.

6. Conditions of work

The conditions of work are crucial for the monitoring safety and security operation considering that a precondition is to work in a safe environment with no disturbances from external conditions in order to be able to observe and immediately recognize and response to alerts. It is important to follow clearly specified responsibilities for all involved parties/staff in order to activate the alert system and operate efficiently in case of emergency.

7. Number of goals and conflict resolution

The goals set are also defined by the requirements of the monitoring plan. Some indicative ones for the UTS are:

- monitoring access to a transport hub
- personnel identification (hub, drivers etc.)
- number of tickets validated at each transit stop
- CCTV videos monitoring data
- counters for boarding/alighting travellers at stops
- complaints office data from hub travellers regarding thieves, violent behaviour, unsafe conditions in the station and/or transport mode operating
- identify the risks involved prior to starting work activities and ensure they are undertaken in a way which minimises the risks, from risky road reports, traffic police data, statistics, threats
- maintain work areas as safe and as free from hazards as possible during work activities;
- ensure equipment and materials are used in a correct, safe manner which is consistent with current legal and organisational requirements and store them safely and securely when not in use;
- put into effect, without delay, the appropriate safety procedures in an emergency- activate real time communication with cooperative bodies (police, traffic police, station security)
- ensure the level of the quality of the data collected – cross check if applicable with evidence of events-reports from security bodies etc.

- provide safety and security information to travellers- time responsive and with alternative paths to follow, along with appropriate information (means and form) covering different travellers needs
- develop event-driven campaigns and ensure stronger dynamic public resilience with a higher rate of travel demand recovery after a catastrophic event.

8. Available time and time pressure

- The required tasks should be executed in an automatic manner so that they would not require additional time from the employees and for them to be protected as well if needed.
- During an event disrupting operations, guidance to the affected travellers has to be given. In the post-event period the focus is on restoring operations, raising awareness of the population and influencing traveller behaviour.

9. Circadian rhythm and stress

- A plan should be defined for managing the risk of employee fatigue and the disruption of the circadian rhythm in safety-sensitive businesses (e.g. a Fatigue Risk Management System (FRMS)) in order to reduce the possibility of critical human errors. Moreover, staff should be adequately trained to manage stress and act efficiently under pressure avoiding panic.
- Safety and Security monitoring tasks should be executed in an automatic manner with threat and risk alerts prior to events in order to avail a safety response time. Still when the risk is unknown the automated emergency response alert should be activated.

10. Team collaboration quality

When monitoring urban transport safety and security the involved parties' collaboration quality is a very critical action that reflects to the response of emergencies. The highest quality of communications is a precondition to properly alert and inform travellers and be able to respond and remain safe and secured. This reflects both to travellers and UTS infrastructure. Within the UTS monitoring plan, responsibilities and authorities should be assigned for the performance of the whole process and its specific tasks.
Team collaboration is needed for:

- defining roles and responsibilities in the process plan, including roles responsible for collecting, recording, distributing, and ensuring the confidentiality, integrity and availability of monitoring data and for
- including process tasks and responsibility for these tasks in specific job description.

The stakeholders involved usually are:

- transport authorities,
- traffic police, police and station security agencies and staff
- transport operator managers, hub and terminal managers
- information technology staff,
- external entities, such as security companies that operate or have under their responsibility the monitoring of a transport infrastructure

11. Quality and support of the organization

The role of the UTS in this case is to provide the safety and security program/plan/ guidance and effectively apply it. This is usually decomposed in the following:

- Establish and Maintain a UTS Monitoring Program
    - Establish a UTS Monitoring Program
    - Identify Stakeholders and external actors/ influences
    - Establish Monitoring Requirements/ Preconditions and Methods
    - Analyse and Prioritize Monitoring requirements and respond actions
- Perform Monitoring
    - Develop/ replace/restore and/or Maintain UTS Infrastructure
    - Establish UTS Collection Standards and Guidelines
    - Collect and Record Information and data
    - Assess data collected, validate, analyse, combine and prioritize data (time-related communication and response)
    - Distribute/ communicate Information

Interdependencies

- The risk assessment report would define the procedures that should be of special focus for safety and security monitoring for the UTS, as the ones of higher risk and thus needing closer attention and preventive measures.
- The Use of the Service controls UTS Safety and Security
- Emergency actions coordination should be in close cooperation with monitoring UTS safety and security, as they should be consulted in defining the emergency response plan and timing along with safety and security critical event detection.
- Operations monitoring should be in close cooperation with safety and security monitoring as the overall monitoring actions for safety and security control within the transport system
- The collection of event information is closely related with safety and security monitoring as these event information data are used to assess and monitor safety and security in the UTS.

Limitations

In case there are no resources or competencies to perform UTS safety and security monitoring, this task may be assigned to an external entity. In this case additional provisions for data security should be made and possible a MoU between the UTS organisation and the external operator should define the details of how the collected data should be managed and exploited. This would require developing and implementing contractual instruments (including service level agreements) with external entities to establish responsibility and authority for performing process tasks on outsourced functions including process tasks in measuring performance of external entities against contractual instruments

Examples

Transportation safety video surveillance

- The benefits of transportation video surveillance are:

- Helps prevent crime and deter criminals
- Prevents vandalism
- Creates safer environment for passengers
- Holds employees accountable for their responsibilities
- Allows for remote viewing off-site from a smartphone or tablet
- Reduces liability in cases of passenger injuries

4.2.2 Monitor Operations

Background facts

In Urban Transportation Systems (UTS), monitoring operations contribute towards a better execution in decision making and mobility actions in the controlled urban area. Responsibility for monitoring, i.e. the collection of the figures, calculation of desired Key Performance Indicators (KPIs) and for comparison of output with target, lies at different levels of supervision. It is important that even junior supervisory staff is aware of the targets and can take corrective action if there is under-achievement, without having to wait for more senior staff to react. Reporting and summarising is done at different hierarchical levels too, but detailed analysis is the responsibility of more senior levels. Monitoring of operational progress should be given the same emphasis, or priority, as applied to other operational activities and would permit the real time intervention on actuation strategies as a result of a real time evaluation of the applied measures.

General Recommendations

Monitoring operational performance can be executed with different timeframe according to purpose:

- Periodic Monitoring: Periodic monitoring involves making comparisons between achievements and strategic targets at the end of specified time periods, for example, monthly, three-monthly or longer intervals by analysing KPIs calculated on statistic basis. It is useful for the definition of strategic mobility plans.
- Continuous Monitoring: Useful at Tactical level, Continuous monitoring is applied frequently to specified KPIs which enable information on plan implementation to be collected often, such as at weekly intervals. Continuous monitoring provides the mobility manager with the means of applying close control over operations enabling frequent comparisons to be made between planned programmes and inputs of resources with actual achievements and inputs.
- Real time Monitoring: Needed at operational level, real time monitoring is needed for system components whose working dynamics can evolve suddenly and the cascade effects can be propagated with unpredictable effects; real time monitoring of the KPIs during operations can evaluate the impact created by the operation itself.

As information gathering and control demands increase, the reliability, capacity and protocol limitations of existing communications infrastructure is constraining organizations' ability to meet performance, cost and security objectives. One of the primary means by which organizations have chosen to improve their capabilities is to begin migrating applications from proprietary protocols to IP because it is more economical and scales better

Common Conditions Recommendations

1. Availability of resources

Humans (labour) – skills/competence

- Human resource availability needs to be secured for both daily activities and during emergency within the responsible mobility agency in case of UTS. A dedicated buffer capacity (e.g., stand-by staff) should be defined in advance and tailored according to emergency scenarios.

- Monitor capability in case of UTS can tightly depend to specific technical and not technical skills (e.g. leadership, problem solving, traffic engineering), knowledge, competencies. In order to control the possible function variability it is necessary to mitigate such dependencies defining a Human Resource

Replacement Plan where missing human resources are immediately replaced with others (properly trained in advance) that are currently assigned to different tasks/activities/roles.

ICT infrastructure

- Most of actuators in case of UTS are based on ICT systems. Therefore, monitoring of the ICT infrastructure should:
  - Have high performance
  - Be redundant
  - Be reliable
  - Have a graceful degradation
  - Not create a significant impact on the system under monitoring.
- Failure of the monitored system should not cause a failure in the monitoring system. Simple redundancy and automatic fail-over is particularly important for monitoring systems, as it is important to "monitor the monitoring," or ensure that an inoperative monitoring system doesn't generate false positives.
- In order to guarantee the operation monitoring and event detection is necessary to set up a proper ICT infrastructure able to collect information for the CI. Operational monitoring should be enabled for all controlled equipment.
- Collecting these data presents its own set of technological problems and general purpose monitoring tools require a great deal of customization and configuration for most uses. At the same time, most specialized monitoring tools only collect certain types of data and must integrate into general purpose systems. In order to support the operation monitoring function properly in the UTS environment is necessary to ensure different models that operate in a layered architecture. The recommended structure includes following components:
  - Knowledge Management Systems (KMS): operators use these systems to query the knowledge base in an easy-to-use and familiar format. KMS automate the capture of structured and unstructured information generated by the operations, the mobility users and the road network to manage unstructured high volume stream of data (Big Data) generated by heterogeneous resources as required.
  - Application Layer encompasses state-of-the-art, integrated algorithms and models that automate CI resilience assessment quantification.
  - Resilience Management Support System extracts knowledge from the data and translates such knowledge into a meaningful mobility dashboard for supporting decisions and consequently actuation of road network management strategies.
  - Computer Aided Dispatch: CAD systems are an essential component of public safety operations. The CAD user's operating environment is characterized by real-time information processing. CAD systems provide deployment and tracking of resources for efficient responses to events. CAD should be designed to process standardised messages as CAP.CAD should include an escalation strategy. It's not enough to simply send alerts: needed to ensure that someone acknowledges the alert and handles the recovery. Since people have "real lives," and aren't always on call, it should be possible to send alert to someone on the front lines, and if

they cannot respond, pass that alert onto someone else. Moreover, it's possible to turn on alerts for many different metrics, but this has the effect of "spamming" administrators, and decreasing the relative (perceived) importance of any given alert. Finally messaging system should be compatible through all available channels in the UTS (VMS, mobile APPs, e-mail, etc.)

- Mobile: Mobile data applications are used for the on-scene aspect of public safety operations. They are designed to provide messaging, state query functionality and display CAD information in the field.

Data management and privacy

- Define where and how the data collected and examined will be stored and maintained.
- Define who will have access to the data and which actions are allowed.
- Define how the confidentiality and privacy of the data will be maintained. The level of
- Define how personally identifiable data will be handled. The
- Use of standard to document data sources.
- Define a data quality profile for each data source and a method for quality assessment addressing the following dimensions: Relevance (Fitness), completeness, consistency, accuracy, timeliness, integrity, accessibility and clarity, comparability, and coherence
- Integrate and fuse data through an holistic driven semantic approach

Monitoring method

- Active monitoring: Monitoring systems that collect data by directly interacting with the monitored systems. Administrators must consider the impact (i.e. cost) of the monitoring and weigh this with the value of the test itself.
- Passive monitoring: Monitoring systems that collect data by reading data already generated by the monitored system. The system collects this data from logs/"traps" or from messages sent by the monitored system to a passive data collection agent. The log data is an example of passive monitoring. Passive monitoring is significantly less resource intensive for the monitored system than other methods.

2. Training and experience

- Increase Risk perception: Dedicated training activates should be organized for the staff in order to gain the desired risk perception level and manage to appropriately interpret the KPIs shown on the mobility dashboard. Risk perception of the staff directly affects the capacity of recognising potential issues, classifying them according to the internal risk procedures and forwarding the information to the right functions at the right time.
- Manage internal Knowledge transfer: This involves managing the internal transfer of knowledge and experience among employees involved in the monitoring activities. Managers, safety specialists, designers, engineers often have inadequate access and exposure to operational filed experts and operational environment. To understand and improve work, mutual access and interaction at vertical and horizontal level should be ensured.

- Train employees in view of system thinking, problem solving and naturalistic decision making. In fact, a critical characteristic of a complex system is its under-specification. This means that existing procedures might not be applicable to an unexpected scenario. Thus the skill of problem solving and situation contextualisation needs to be acquired through adequate training, for the employees to be able to cope with unexpected issues.

3. Quality of communication

- Support efficient shareholders and (internal and external) stakeholders/experts coordination and cooperation.
- Guarantee the accuracy and understandability of the communication through standardized communication tools, protocols and languages.
- Secure data understandability.
- Provide early warnings triggered by defined thresholds in relation to desired KPIs.
- Report continuously operational performance for UTS infrastructure maintenance.

4. Human Computer Interaction and operational support

- Equipment should be designed in accordance with key ergonomics standards including EN614 Parts 1 and 2.
- Control rooms should be designed in accordance with key ergonomics standards and best practices (e.g. EN11064, EEMUA 191 and EEMUA 201, High Velocity Human Factor).
- Staff should be involved in the design process. This should include different types of users including operatives, maintenance and systems support personnel.
- Monitoring interfaces for UTS 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.
- Information messages should be standardized (e.g. Common Alert Protocol-CAP).

5. Availability of procedures and plans

- Defining clear Standard Operational Procedures (SOP) that recognize distributed decision making requirements.
- Enabling procedure and plans accessibility and wide dissemination within the organization. All kinds of communication channels should be used like email, intranet, leaflets, etc.

6. Conditions of work

- Establish a “Safety culture” means the value and priority replaced on safety across all levels within an organisation. It refers to the extent to which individuals commit to their personal safety (independence) and to safeguarding others (interdependence). It is necessary to go beyond the classical
- Approach based of the fear of repercussion and consequences (or reward conformity) towards the true commitment to safety and adaptation as an internal organization value.
- Leverage the role of context and culture in order to socially influence the right behaviours. In fact social influences have the propensity to change an employee’s thoughts, beliefs and values, which in turn, can shape their behaviour. An example of social influence is the organisational culture of a workplace and the style of leadership that governs it.

- Just culture signifies the growing recognition of the need to establish clear mutual understanding between staff, management, regulators, law enforcement and the judiciary. This helps to avoid unnecessary interference, while building trust, cooperation and understanding in the relevance of the respective activities and responsibilities.

7. Number of goals and conflict resolution

- Adopt a minimum performance for UTS operation. Define a set of desired KPIs that enable monitoring of both field equipment and the conditions of the road network (e.g. Level of Service) when applying mobility actuation strategies.

8. Available time and time pressure

- Understand demand over time. It is important to understand the types and frequency of mobility demand over time, whether one is looking at ordinary routine work, or a particular event. Identify the various sources of demand and consider the stability and predictability of each.

- Separate value and failure demand. Where there is failure demand in a system, this should be addressed as a priority as it often involves reworking and runs counter to the system's purpose.

- Look at how the system responds. When the system does not allow demand to be met properly, this will result in more pressure. It should be considered how the system adjusts and adapts to demand, for understanding the trade-offs used to cope. Field experts should be consulted and signals that may indicate trouble should be seek.

9. Circadian rhythm and stress

- Managing fatigue and workload as hazard: Fatigue refers to the issues that arise from excessive working time or poorly designed shift patterns. It is generally considered to be a decline in mental and/or physical performance that results from prolonged exertion, sleep loss and/or disruption of the internal clock. It is also related to workload, as workers are more easily fatigued if their work is machine-paced, complex or monotonous. Compliance with the Working Time Regulations alone is insufficient to manage the risks of fatigue. Measures to manage fatigue are:

    - Ensure that workload assessment considers visual inputs (e.g. scanning display screens, looking out of windscreens, CCTV), auditory inputs (telephones, radios, alarms), cognitive activities (analysis of inputs, decision making) and psychomotor skills (physical actions, such as controlling a process using a mouse, keyboard, or buttons and levers).

    - Consider not just the number of personnel, but how they are being utilised.

    - Set clear roles and responsibilities, ensuing that staff are clear on their priorities. This will help to ensure that even when workload is high, staff is able to focus on key activities.

    - Some tasks may be re-allocated from humans to machines/computers, or vice-versa; considering human performance, safety, maintainability, personnel requirements, etc.

    - Develop a policy that specifically addresses and sets limits on working hours, overtime and shift-swapping, and which guards against fatigue.

10. Team collaboration quality

- Consider the information flow: Field experts of all kinds, (including system actors, designers, influencers and decision makers) need effective ways to raise issues of concern, including problems and opportunities for improvement and need feedback on these issues.

- Ensure collaboration within the responsible mobility agency and also among the responsible mobility agency with public emergency services.

11. Quality and support of the organization

- Active monitoring - By "active monitoring" we are referring to all those checking activities, formal and informal, carried out by line managers which lie at the heart of effective management. Active monitoring involves checking that all these components, people, equipment and systems, continue to work as intended. What distinguishes it is the recognition that the topics which are actively monitored must include those barriers or controls needed to prevent a major accident. This needs to include preventive barriers as well as those barriers which are intended to mitigate the consequences of the event if it materialises. In particular an effective active monitoring program will ensure that the staff are:
    - doing what they should be doing and checking what they should be checking;
    - reporting what should be reported and to the right people;
    - taking appropriate action on the information provided particularly to remedy
    - identified deficiencies in risk control systems.

Interdependencies recommendations

- Monitoring function is strictly connected with the emergency coordination function.
    - Moving from the single-ended monitoring of the past to the integration of multi-monitoring and central control systems, evolving from "monitoring without control" into smart, integrated systems. Simple data acquisition is inadequate for current circumstances, and systems must be enabled with decision support tools and also with strategy actuators modules.
    - Need of control, sensor networks, fault diagnosis and computational intelligence tools for handling in real-time highly complex data generated at different geographical locations in different formats.

Limitations

- Improving the effectiveness monitoring and early warning UTS systems does not lead always to reduced risk for disaster-prone communities — early warning does little good unless it is followed by (early) action.

Examples

Emergency Operations Centre of the Makati City, Philippines

The Makati Command, Control and Communication (Makati C3) centre was developed to serve as the city's Emergency Operations Centre dealing with monitoring, coordination, and integration of services and resources during disasters and emergencies with an active role in risk-sensitive land use planning and community-based disaster risk reduction. Read more at http://tinyurl.com/7su6wtw

4.2.3 Monitor Resource availability

Background facts

In the face of inevitable resource limitations, every organisation strives to maximise operational efficiency. Across all industry sectors, access to diverse and variable resource needs relies on increasingly tight system couplings that must be developed and sustained amongst supply chain stakeholders. The high complexity and dynamics that emerges from such system interdependencies require a continuous ability to monitor the flow of multiple critical resources, aiming to develop updated and thorough support to the planning of operations and the subsequent allocation of resources. This may be particularly relevant when faced with the need to re-plan and adjust to changes in the operational environment. The scale (local, regional, national, international) of transport systems operations poses additional challenges in terms of resource management and control.

The considerable exposure and contact with the public in general is at the source of specific operational uncertainty factors, which also contribute to an increased operational variability and uncertainty, and therefore to additional challenges for resource management and control. Recent technology developments (i.e. automation and remote control and monitoring of operations) facilitate the integration of important adaptive capacities into transport operations, but this also increases operational complexity that often manifests itself across critical human decision-making processes.

General recommendations

A sociotechnical system goes much beyond the description of its human, technological and organisational resources. Understanding the interdependencies that ensure system functioning and operation is fundamental for the safe, effective and efficient allocation and deployment of resources. This understanding should seek:

- The way in which interdependencies support the provision of critical resources;
- The types and degrees of variability to which these are submitted in the face of pressures emanating from a system's operational environment.

Monitoring resources availability implies that operational variability of the system must be considered and managed in order to ensure the system functioning. The resources and system capacities required to manage and cope with operational variability must also be taken into account. In many transport networks, regardless of their sector (rail, light rail, bus services) and despite considerable developments in communications and in operations monitoring capabilities, the use of local staff and on sight operational agents has shown important safety and efficiency benefits:

- Improved efficiency in passenger flows (i.e. boarding and transfer)
- Improved safety, security and operations monitoring
- Improved response to events and operational changes (i.e. re-allocation and deployment of resources)

Common Conditions recommendations

1. Availability of resources

- Humans (labour) – skills/competence

Technical and organisational conditions ensuring acceptable workload, managing fatigue and stress in order to anticipate negative effects on job performance, controlling workability across ageing, and promoting health, arousal and preparedness towards prompt reactions in emergency situations.

- Budget:
  - *Ensure the required budget for the system functioning and emergency situations.*
  - *Preview the needs for external operations and the related budget.*
- Data & Algorithm:

N/A

2. Training and experience

- *Provision of conditions for the development of competencies with experience, as requisite for awareness on local conditions in the scope of overall operational understanding.*
- *Ensure training for emergency situations in relation to the use of all resources.*

3 Quality of communication

Information constitutes one of the most critical resources, but it is also a very dynamic and uncertain one. The efficient and safe use of this resource is strongly reliant on the accuracy and quality of communications. The use of reliable and purpose oriented (suitable for operational needs and conditions) communication technology, and of appropriate communication standards and language are particularly critical for transport operations. Miscommunication issues are frequently found at the source of transport incidents and accidents.

4 Human Computer Interaction and operational support

IT technologies are a critical resource, based which information as an equally critical resource is processed and deployed. Together IT technology and information support the majority of operational decision-making in every industry sector.

Control rooms are currently one of the most critical areas of transport systems. Automation and IT technological developments has considerably increased remote control and centralisation capabilities but not without increased complexity and demands for control room operators. Control room systems design and appropriate support to decision-making processes is thus placed at the core of transport safety and efficiency at large.

5. Availability of procedures and plans

Procedures and planning should support local staff in the efficient and safe allocation of available resources, whilst ensuring the necessary coordination with stakeholders across operational interdependencies. They should also support the ability to efficiently and safely adjust to unanticipated changes in operational conditions, wither through the activation of contingency plans or through the re-planning and re-allocation of resources.

The use of variable levels of operation capacity in transport systems, in order to adjust to changing operational conditions (i.e. weather conditions, social events…), has shown to improve operational reliability and service quality. This can be achieved through forums of operations related staff that review available data to forecast operational conditions for upcoming days or weeks and establishes a level of operation capacity of the network (or for the parts of it potentially affected) to the forecasted conditions.

6. Conditions of work

Management of resource needs is crucial for adequate conditions of work. Human resource needs are particular variable and therefore likely to require additional planning and management efforts.

7. Number of goals and conflict resolution

Resource scarcity is at the source of conflicting and competing goals. Monitoring the adequate allocation and deployment of resources is critical for the management of trade-offs between operational goals and needs in such a way that safety requirements are not compromised.

8. Available time and time pressure

Time is a unique type of resource and one without which no decision or operation may be carried out. It also has the unique characteristic that even when it is not being used (for any given operational purpose), it is inevitably under consumption. Thus, time pressure is virtually unavoidable but must nevertheless, be adequately managed. Planning must account for suitable timeframes for all operational needs and should *integrate time buffers in line with "operation deliverability risks".*

9. Circadian rhythm and stress

- *Shift work or roster conditions may impose the need for more flexible management and deployment of resources. Monitoring resource availability may become more complex due to increased diversity and variability of factors to be taken into account.*
- *Circadian rhythm asynchrony has important effects in performance, which are related to decrements in vigilance. Human resource needs should be regularly and closely monitored to identify any potential additional needs emerging in relation to such phenomena.*
- *Uncertainty in relation to the availability of resources significantly contributes to increased stress, particularly in situations where important variability of resource flows is to be expected. Suitable resource monitoring can contribute to stress management.*

10. Team collaboration quality

Efficient team work can compensate for many different situations emerging from resource shortage or outage. The effectiveness of nay team strategies in this sense is strongly reliant on any anticipation capabilities in relation to any potential variations in terms of resource availability. Providing teams with the means to monitor the processes through which access to their critical resources is secured can considerably improve the success of team collaboration.

11. Quality and support of the organization

Resource variability, shortages and outages imposes the need for trade-offs between business and operation priorities. Avoiding any (negative) safety and performance impacts of such trade-offs should be grounded on solid organisational support to the coordination and cooperation between multiple local needs.
In transport systems, organisational resources are particularly critical for the coordination between multiple and diverse local needs and conditions that are likely to be dispersed across considerably different cultural economic and geographic conditions.

Interdependencies recommendations

Monitoring resources generates information on resource allocation and the understanding of their flows. This constitutes one of the fundamental tools for planning activities, both as a primary input and as indicators for the potential need of planning revision or reassessment.

ICT constitutes a fundamental resource for all operational and managerial activities. The failure of ICT services may critically compromise operation continuity. The monitoring of these services should provide the ability to anticipate potential disruptions and the deployment of contingency resources (adaptive capacities).

Keep updated information on the status and supply of critical resources constitutes a fundamental resource for the anticipation of potential needs for operational adjustments.

In case the ICT infrastructure needed to support the resource monitoring fails, a dedicated communication and periodic reporting channel should be established with the suppliers. Reporting data about the resource consumed should be provided "on demand" and on pre-determined period.

A specific protocol and procedures to promptly inform about resource delivery failure and the related causes should be defined in advance between the CI and its suppliers. Such procedures should be included in the emergency plan of the parties.

4.2.4 Monitor user generated feedback

Background facts

A disruptive event affecting a UTS significantly impact the social opinion, at different levels, depending on the "effect" induced by the event (e.g. the impact on the opinion of citizens is different if a disruptive event generates a reduction in the quality of service rather than causalities).

The widespread of mobile technologies – more specifically smartphones – and social networks (e.g. Twitter, Facebook, Instagram, etc.) has enabled an every-time and every-where collaborative and active participation of citizens, who are free to generate and share information and opinions about any event occurring in their daily lives. With respect to UTS, social networks/media are largely used by citizens, specifically commuters, to share updated information about inefficiencies, delays and other events (such as, sudden traffic jams, unexpected strikes, etc.). This allows for having a large set of "human/social" sensors in different locations within the cities, even moving, reporting useful information both during the emergency/event than after that.

Indeed, in case the communication network is not affected by the disruptive event, social/human sensing is crucial to gather useful information which cannot be otherwise acquired, for instance information about the entity of the event in an area which is not monitored through ICT systems. In this case, the human/social sensor is crucial to support the emergency management and identify impacts on the UTS that could affect the effectiveness of the rescue and emergency management teams.

After an event, the social/human sensing becomes crucial to analyse the opinion and facilitate both recovery to the normal situation and system adaptation. For instance, human/sensing can be adopted to infer the perceived level of security and safety of the citizens after a disruptive event (e.g. a terrorist attack) on the UTS, as well as to identify possible criticalities, reported by the users, which represent barriers to the acceptance/usage of the transportation service. Furthermore, the information shared by commuters may support a more effective, efficient and socially-accepted planning of the services, optimizing resource allocation to support investments in actions to reduce risks and improve overall resilience of the UTS (adapt phase).

General Recommendations

A bottom-up engagement of travellers in the resilience management of a UTS may be leveraged by social media monitoring ("social/human sensors", "travellers as moving sensors", etc.). The analysis of the user generated contents requires adequate software tools, such as Text Mining and Natural Language Processing (NLP) software applications. Structured real-time information related to road traffic density, level of service, speed or public transport ridership, may be derived through ICT technologies (road sensors, smart card ticketing readers, etc.). A combined analysis of smart devices' geolocation (structured) data and tweet contents (unstructured data) can provide a r picture of transport incidents and travellers behaviours in different situations. Cloud-based platform for Big Data management & analysis provide meaningful visualization of aggregated information, both for ex-post and real-time analysis.

Common Conditions Recommendations

1. Availability of resources

Humans (labor) – skills/competence

- Personnel in charge to monitor and manage communication channels requires training to use simple social media monitoring and social network data analysis tools. The aim is to detect and infer useful information, “hidden” in the user generated contents, to define suitable communication material for supporting a more rapid recovery to the normality of the UTS usage.
- Stakeholders involved in the emergency management have to be able to access social/human sensing data as any other data source (ICT monitoring and control systems), in order to have a more comprehensive view of the current situation and, in case, to involve citizens for improving the effectiveness of operations/actions.

Budget

- Costs for accessing, implementing and updating of social/human sensing data must be considered.

Data & Algorithm

- Data which can be crawled from the web and the social networks, with a focus on contents related to UTS.
- Data collection from blogs and App that may be dedicated to gather feedbacks, comments, scores, images relatively to the transportation services and specific geo-localized elements such as bus stops, racks, traffic lights, plates, underpasses, bridges, etc.
- Software tools for analysing – online and batch – the crawled data, with a focus on time-series and trend analysis, Natural Language Processing and Text Mining, Sentiment and opinion mining, Statistics and Data Mining

2. Training and experience

- Training on social media monitoring and opinion/sentiment analysis tools
- (Social) communication skills
- Basic expertise in statistics and Data Mining

3. Quality of communication

- Communication material aimed at supporting a quick recovery to normal usage of the UTS
- Diffusion of the communication material on the different channels, in particular social networks and media, in order to reach any user (commuters, tourist, citizen in general) independently on his/her preferred media/channel and to reduce/avoid any possible “digital divide”.

4. Human Computer Interaction and operational support

- Access to social/human sensing data and data analysis software for supporting the UTS operators during the emergency management.
- Access to social/human sensing data and data analysis software for supporting the personnel in charge for communication to quickly recover the normal level of usage of the UTS as well as to support the definition of adaptations to the overall UTS.

5. Availability of procedures and plans

- Procedures related to the communication to the public have to be frequently revised/updated taking into account the most used/preferred social media channels over time (they might change according to the availability of new apps, new social networks, new channels and devices).

6. Conditions of work

- Guarantee privacy and security of the public data crawled from the web and social networks – according to the internal and local policies.

7. Number of goals and conflict resolution

- Reducing efforts during the emergency management while increasing its effectiveness, by exploiting data and information from social/human sensing.
- Increasing the amount of data and information available during the management of the emergency, integrating social sensing to data coming from monitoring and control systems as well as other external official sources.
- Reducing time to recover the normal condition

8. Available time and time pressure

- Personnel must be trained and put under exercises to achieve good skills in extracting useful information from human sensing data
- Access, browse and examine data in very short time through easy friendly visualization
- Prompt and quick actions and timely monitoring for prevention

9. Circadian rhythm and stress

- N.A.

10. Team collaboration quality

- Adherence to the principles of collaborative planning through the development of mutual benefit relations, during the management of the emergency and the recovery and adaptation

11. Quality and support of the organization

- Alignment of responsibility for communication actions

Interdependencies recommendations

- Analysis of user generated data crawled from web and social media must be correlated with official data coming from ICT based monitoring and control systems relatively to UTS service and its level of usage.
- Communication mechanisms and channels used to check the UTS service usage and increase travellers awareness are relevant sources of information to be monitored.
- User generated data crawled from web and social media can be used as further source of information (social/human sensing) to improve effectiveness and efficiency of the UTS service delivery and, more important, to support a quick recovery to the normality by addressing the feedbacks generated and shared by the users (both commuters and tourists) and citizens in general.
- User generated data crawled from web and social media can be used as further source of information (social/human sensing) to improve effectiveness of emergency actions, in particular to retrieve useful information in areas not covered – temporary or permanently – by ICT based monitoring and control systems.
- Data generated by users/citizens must be analysed and processed to extract, collect and monitor relevant information about events affecting the UTS.

- Communication mechanisms and channels can be refined and improved to infer, characterize and possibly predict UTS usage behaviour as well as increase travellers awareness and implement transportation demand side management strategies.

Limitations

Trustworthiness of the sources: data generated by citizens, contrary to official data sources (such as ICT based monitoring and control systems), cannot be completely considered "trustworthy". Data analysis can allow for the estimation of trustworthiness of the sources to minimize – but not exclude – misleading information. In cases that feedback is collected by social media accounts, the validity of information and time of posting is also a matter of limitations.

Examples

Commute London case - Twitter train travellers generated feedback monitoring

Commute London, considering the human impact of delays on the London railway, gives transport rail operators the opportunity to shape their recovery and resilience plans around the needs of users. Taking feedback from travellers, based on real-time monitoring of Twitter accounts, provides advise to rail passengers and staff of problems likely to impact the services before, during and after the official sources have reported an incident.

For more information: http://commutelondon.com/resources/TwitterTrainsofThought2015.pdf

4.3 Respond

4.3.1 Coordinate emergency actions in UTS

Background facts

Urban transport systems are a very critical infrastructure in community life. During both ordinary stresses and extraordinary emergency conditions there must elasticity and readiness to either shutdown the systems and consequent traffic redirection.

UTS reconfiguration, UTS shutdown, and evacuation of people are concepts that must be considered in an escalation, but in reality they might be all present in a pragmatic (and not rarely dramatic) mix of emergency actions to be coordinated. Consequently, UTS operational status can be evaluated in significantly different manners, according to the gravity of the emergency event.

In case of a limited flood, or in case of cloudburst, only a part of the city might be affected, with circumscribed need of mobility re-routing, to be coped with appropriate UTS management tools. In case of major events, it might be necessary to operate massive transport redirection, to organize evacuation of people in a state of need, to grant access to medical assistance or civil protection into the affected area, to shutdown the entire UTS system.

In any case, a resilient city need to properly address the coordination of emergency actions in UTS, by implementing suitable preparatory and preliminary actions and by putting the different actors in condition to operate rapidly and efficiently during emergency.

During emergency conditions, UTS functionality might be guaranteed as a “best effort” service level, i.e., the minimum availability which is capable to evacuate population, to re-direct traffic flows out of the affected area, to grant a minimum service to people living out of the affected area.

General Recommendations

To this extent, the coordination of UTS emergency actions includes:

- Assuring leadership on system operation until emergency is closed
- Redefinition of service needed in the given emergency magnitude
- On-the-field coordination activities to manage road signs to advertise traffic changes
- Re-routing & timetables rearrangement of UTS when and if possible
- Cooperation with other first responders/law enforcement such as local police and civil protection
- Complementarity of mobility modes in case of enduring service level loss, in accordance with service level agreement
- Communication of the current mobility conditions to citizens and stakeholders
- Caring the diffusion of clear contents, in proper channels

Common Conditions recommendations

1. Availability of resources

Humans (labour) – skills/competence

- In order to rapidly address the necessary issues during emergency, members of the emergency coordination staff should include people who profoundly know the UTS, its commuters and occasional users, the frequent users and the general public, along with their territory, counting on their own personal experience as inhabitants, pedestrians, drivers, and commuters.

- In addition to scientific, technical, legal and procedural education, there shall be exercises, simulations and case studies, as a preparation to cope with UTS re-adaptation during emergencies.
- Simulations and trials must be conducted on a regular basis in order to improve ordinary stress and extraordinary emergency awareness, with a particular emphasis on empathy with the general public.
- Emergency actors must know each other in person, having clear, fair communication, and having established a relevant human empathy among them in the ordinary time, well before the emergency begins.
- The members of the emergency response team should be periodically trained together, in order to facilitate their communication and relationship.
- In all the phases of a crisis response, a robust communication and information plan must be implemented, involving all the main communication actors.
- In particular, those dealing with IT, communication, patrolling must be used to cooperate in ordinary conditions, since those profiles need to be very rapidly interoperating during emergency.
- Specific skills of employees capable of working and acting on obsolete “analog” UTS subsystems need to be maintained in the organization, in order to be able to manage subsystems in very extreme conditions where digital and modern transport assets might quickly degrade.

Budget:

- Financial reserves to be accessed in case of UTS emergency should exist.
- A proper financial planning devoted to resilience and crisis management must be included in the overall budget definition process, with special focus on UTS obsolete and up-to-date technologies, which require different attentions and considerations.
- A proper insurance system should exist in parallel with crisis management budget, to be used in order to cover costs and risks, which the Organization might not be able to cover with its own financial resources.

Data & Algorithm:

- Crisis Management team should have immediate access to all the relevant data organized in friendly and easy ways, for example through dashboards.
- Dashboards must present understanding at a glance current conditions of the city mobility: contextual data, strategic infrastructures, telecommunication networks, road graph status, traffic sensors data, people flows, should all be accessible to the emergency coordination team in charge of guaranteeing operations of the UTS infrastructure.
- These data should be possibly available and accessible even without networking and power supply infrastructures, through local copies, data backup, business-continuity and emergency recover solutions.
- Algorithms for strategies have to be available and operative even in the lack of internet connection communicating in other means with devices and operators. All the devices and operators in the hierarchical control architecture have to provide a minimum level of operative-ness in the case of strong degradation of data flow.

2. Training and experience

- Due to the UTS operations complexity, specific project management, coordination and human relations skills are necessary in the crisis management team.

- When new tools, such as new digital communication channels, are introduced within the operational procedures (e.g., the usage of WhatsApp or Telegram to communicate with people), a specific training program must be planned and enacted as soon as possible.
- Specific training must be ensured also for those UTS subsystems requiring very particular and specific skills, such as obsolete and analog subsystems, old legacy assets.

3. Quality of communication

- In a crisis scenario, where multiple actors have to quickly react and coordinate, communication is a critical factor to be properly managed and addressed.
- UTS emergency procedures need to specify who is in charge of communicating what, to whom, when, and on which channels, regarding mobility conditions in the city.
- Decisions must be rapidly delivered to the person/entity in charge of communication and multiple and redundant channels need to be activated, maintaining the uniqueness and the accessibility of the information itself.
- Time and effort must be dedicated during the planning phase in order to ensure that the same terms are well understood and agreed by the different actors of the crisis response process.

4. Human Computer Interaction and operational support

- The opportunities of new digital media and tools need to be leveraged in order to maximize the effectiveness of the emergency actions. Not only social media and common messaging tools, but also game-based training and augmented reality applications can be used to collect possible requirements from stakeholders, and to train on best practices of crisis management.
- Regarding the software adopted within the emergency coordination centre, user interfaces should be periodically revised and analysed, in order to ensure that information is provided instantly in a clear and simple way to the specific decision-maker. Multiple login should be avoided in order to save time to access information, promoting single sign-on across the different information systems.
- UTS management systems are usually very complex and specific of the single type of UTS infrastructure. To this extent, particular care must be paid to the switch from general dashboards to specific UTS management tools, in order to avoid confusion and interpretation errors in the emergency control room

5. Availability of procedures and plans

- Preparedness implies planning and it must be carried at all the organizational levels.
- Coordination of emergency actions is responsible for setting up, maintaining and updating general, localized, specific plans for each kind of risk, based on risk identification, analysis, evaluation and reduction.
- Approved and updated procedures and plans need to be properly published and made accessible to the different actors.
- Meetings with the emergency coordination team need to be periodically (at least twice per year) organized, and be used to disseminate and promote knowledge of the approved procedures.
- Public utilities in charge of managing the different city transport systems need to be forced to produce and share easy-to-understand procedures explaining the behaviour of their UTS in case of emergency: which functionalities can be guaranteed under which conditions and event gravity, and which inter-relations with other transport systems need to be particularly taken into account during emergency.

6. Conditions of work

- UTS emergency response and management actors need to be endowed with proper tools, instruments, and skills to behave correctly and effectively, according to the approved procedures.
- Proper personnel shift and timetable scheduling need to be organized in the planning phase, by reducing as much as possible stressing conditions, and by rotating personnel as possible given the emergency conditions.
- The organization need to provide workers of proper insurance guarantees covering the risks associated to their activity.

7. Number of goals and conflict resolution

- Operational emergency procedures need to include the expected goals of each emergency response process (e.g. to restore viability under a flooded road underpass)
- After crisis solutions a proper assessment need to be implemented to check the occurred conflicts (e.g. actor X thought that actor Y would have solved issue Z, actor Y thought it was a duty of actor X).
- Occurred conflicts need to be addressed, solved and reported in the following operational procedure update.

8. Available time and time pressure

- Simulation and training programs need to address the time pressure issue, workers need to be trained to react with prompt actions, and decision makers need to be trained to solve issues in due time.
- Risk assessment and critical system functions need to take into account the time after which the damage and impact of an unavailable resource is going to worsen (e.g., after 6 hours of power supply downtime, hospital or local bus authority AVM temporary power supply system is going down).

9. Circadian rhythm and stress

- There must be specific psychological training of the personnel involved in the emergency response to cope with stress. In particular, UTS personnel must be ready to act individually, in potential loneliness, or in the necessity of leading other people to deal responsibly.
- Working shifts may take into account wake/sleeping rhythm and manage shifts according to the severity of the event and to the availability of human resources.

10. Team collaboration quality

- Training courses may include team working and group-working, thus improving relationship and group empathy among the emergency coordination team members.
- Specific training programs for work under very stressful situation need to be implemented at least once per year.

11. Quality and support of the organization

- The UTS emergency organization needs to annually check the human resources, technological tools and equipment requirements from the emergency coordination team.
- Periodical meeting occasions need to be scheduled by the organization in order to show the emergency coordination team to the rest of the organization, thus promoting communication flows across the vertical departments and the emergency coordination team.

Interdependencies

- The coordination of UTS during emergency is executed under critical circumstances, where decisions may imply serious consequences on city transport and mobility services, not to mention human lives and properties.
- Decisional process must remain under a clear responsibility, at the higher level required.
- Emergency coordination and the consequent actions on UTS configuration need to be performed in very strict scheduling therefore a short time to reaction – together with the complexity of actions on the transport systems, may limit the capability to act effectively.
- In order to reduce competence gaps, a deep knowledge of the city transport systems and of the possible consequences of each action need to be assured in the emergency coordination team.

Limitations

- Poor security culture and awareness in travellers and UTS staff.
- Limited resources and time for training of UTS staff.
- Extremely dynamic processes with high volumes of vehicles and travellers to be managed during crisis.
- Communication gaps among the different UTS actors.

Examples

Albay Province, Philippines Risk Reduction case

- The Albay provincial government in the Philippines established a permanent disaster risk management dealing with the high risk of typhoons, floods, landslides and earthquakes. This case is a great example of urban planning and UTS disaster prevention, preparedness and response that have been well coordinated. Read more at http://www.unisdr.org/we/inform/publications/13627 (page 48) and http://tinyurl.com/ck6btnb.

Torrigiani collapse in Florence

- Coping with soil collapse, expecially in crowded, fragile historical cities, as in the case of the collapse of Lungarno Torrigiani in Florence, on May 25 2016, requires a higher level of UTS and city authority coordination. The Municipality of Florence intervened with its power of civil protection coordination, to quickly grant traffic re-routing down the historical center, to grant a fast reconstruction of the historical promenade along the river Arno, to preserve quality of living and staying in Florence in the post-emergency time.

4.3.2 Restore/Repair operations

Background facts

Severe incident impacts comprise physical and social impacts, in particular with respect to UTS. Physical impacts can be subdivided in impacts on infrastructure as well as on services and processes. A small-scale disruption could not have a significant impact on physical infrastructure (e.g. a temporary interruption of a connection between two stations due to technical difficulties) but can heavily impact the level of service and the quality perceived by the users (e.g. a delay during the peak hours when commuters are moving to go to work).

Damage of infrastructures may cause direct service and process-related problems. However, restoring infrastructures is not always sufficient to repair in order services and processes linked to them. Furthermore it is necessary to act quickly to restore services and processes to avoid wider social impacts including economic and political implications.

With respect to UTS, in case of an adverse event, the mobilization of stand-by O&M personnel, activation of a staff recall system or a HR replacement plan, are actions possibly needed. Spare vehicles or a retraction of alternative modal carriers based on SLAs may retain transport capacities.

IT resources such as telematics or a computer-aided dispatch of vehicles and drivers enable the recovery of scheduled services.

UTS services may be disrupted in many different cases, having direct impacts on community processes. The impacts can be classified as follows:

- localized impacts (e.g. local traffic jams due to large-scale incidents)
- diffused impacts (e.g. traffic and public transport congestion due to meteorological events; railway network block due to derailments);
- area-wide impacts (e.g. dramatic events like 1966 Florence flood or 2009 L'Aquila earthquake affecting most of the urban CIs, not only UTS);

Despite the fact that infrastructures are normally managed by the public authorities, services and processes are almost always outsourced to private or semi-private companies, such as for urban transport. The latter are then responsible for the continuity of services, their implementation and for communications to citizens and institutions. Institutions instead care for infrastructures on which the services are dependent. Relations between the two entities are normally controlled by previously signed contracts. The processes and recovery periods in case of service problems or disruption are normally foreseen in these contracts.

General recommendations

A Disruption Recovery Plan should be in place to restore routine UTS activities that were disrupted at a differing scale. This Plan should encompass activities planned before disruption and those improvised after a large-impact unforeseeable incident.

Sufficient resources should be foreseen at least for short-term recovery at an acceptable level.

As the aim is to restore urban transport services to their initial level, the restoration of modal services enables cross-modal network operations of the transport system as a whole.

Common Conditions recommendations

1. Availability of resources

Humans (labour) – skills/competence

- Stakeholders of Restore and Repair operations should be people who profoundly know the relation between the UTS and the overall urban environment, including the other urban CIs, in relation to the essential functional priorities (technical and procedural) of which they are in charge. Their working vision should be based on an integrated operational approach, which encompasses a set of actions useful to recover people's daily activities, public and sensitive data mobility and goods transport, but also to obtain a life-line system for rescuing people and economic values and for repairing and restoring all the interconnected systems – internal as well external (e.g. other interconnected urban CIs) – when they are disrupted. In relation to this dual aspect people involved in the function should maintain their skills and competences at a high level, by means of recurrent trainings in the field of smart cities, smart mobility/transportation, urban planning and urban resilience activities. Such acquired expertise must be shared with the territorial management authorities in order to maximize the effectiveness of the possible restore and repair activities, to optimize the intervention times within the local planning rules and to ensure continuity between the emergency phase and the ordinary management phase.

Budget

- In case of critical situations that turn into emergencies, financial reserves should be budgeted in advance for restore and repair. The allocation of support funds should be budgeted in relation to the current status of the UTS and relative risks. The portfolio should also have a wide margin of use because of the variability of each possible event in terms of typology, level of criticalities and extension. In this perspective, funds must be designated both by the involved private/semi-private companies and the public entities in relation to their responsibilities.

Data & Algorithm

- Use of standard documentation for data and algorithms
- Use of recognized project management concepts
- Use of standardized models and protocols
- Production of KPIs in order to manage the required action plans
- Use of historic data in relation to short-term / long-term responses (natural and man-made) for likely critical scenarios within the urban context
- Acknowledgement of existing legal acquis, local conditions and regulatory regimes
- Definition of the exact relationship between infrastructures and services /procedures is a sensitive issue, but it can provide major advantages in terms of resilience. This relationship must be properly applied to simulation models when restore and repair aspects are tested and validated. Models are used to prepare backup services and redundant procedures that can avoid problems due to localized disaster impacts, as well as to mitigate and absorb problems due to diffused disaster impacts. The same models can also identify stressful situations that must be avoided in order not to become fatal in case of disaster.

2. Training and experience

- Social and territorial data analysis, network examination and software simulation by capable experts
- Management and coordination skills to collect the contingent information and to plan restoration activities
- Expertise in financial and environmental management, procurement and technical issues in design, construction, maintenance and operation
- Human factor and communication training and experience (e.g. for the estimation and management of fear)

3. Quality of communication

- Guarantee a complete and clear share of knowledge, data and aims among all the actors and from actors to the end users (active interaction) at all stages of the implemented actions
- Guarantee the accuracy and understandability of the communication through standardized communication tools and protocols

4. Human Computer Interaction and operational support

- Utilization of software tools to analyse the impact of the operational strategies which could be applied to the disrupted system, also supporting the socio-economic cost-benefit evaluation
- Utilization of software tools to analyse data and develop focused intervention plans
- Utilization of social networks to collect data and information about the opinion of users (both commuters and tourists) and citizens in anticipation of recovery actions
- In a normal situation or in case of emergency, the monitoring of the services/processes is directly connected to the monitoring of infrastructures, with all the temporal, qualitative and quantitative connected considerations. *However, the disruption of services and processes may also have great social impacts. Therefore, it becomes important to monitor and to be able to interpret feedback from media and social networks. It is difficult and it takes time to evaluate the psychological impact that the lack of a service may have on the population. But being able to understand what services and how their quality is perceived by UTS users as belonging to a normal situation is a key point to focus energies.*

5. Availability of procedures and plans

- Open planning process to effectively outline the structural and non-structural list of actions
- Strategic financial and operational plans according to likely scenarios to be repaired
- Procedure for fast availability of all the necessary resources

6. Conditions of work

- Consider in advance specific legislation to ensure that personnel may bear responsibility, also under an effective insurance system
- Knowledge and awareness about recovery priorities following the emergency, in order to disseminate properly funds, material and human resources
- Capacity to facilitate the cooperation among the different stakeholders during the debriefing activities and all stages of the field operations

7. Number of goals and conflict resolution

- Tangible strategic and tactical measures to restore the ordinary and fully operational conditions that were disrupted by incidents.
- The operating units should be organized taking into account the scale of the problem and timeline of the plan
- Quantitative and qualitative measures about the expected impact of the deployed procedures
- *Definition of the activities that must be planned before and in anticipation of an incident impact and those that must be improvised only after an incident.*

8. Available time and time pressure

- Immediate response needed in order to restore basic services as soon as possible
- Function must be planned to act in short-term recovery and long-term reconstruction based on the importance of the services/ processes

- Restore timing plan: depending on how crucial the operation is for the whole system operation, the pre-event recovery plan should define time-critical restoration activities. In a (chrono) logical order, transport demand recovery follows service restoration.
- A continuous (daily) monitoring of the transport operations recovery is advised.

9. Circadian rhythm and stress
- Restore quickly services/processes the lack of which can stress ordinary life
- *Identify what services and how their quality are perceived by UTS users as belonging to a normal state of operations*

10. Team collaboration quality
- Adherence to the principles of collaborative planning
- *Collaboration and cooperation between institutions and private companies which operate services/processes is very important*

11. Quality and support of the organization
- Clear decision making process and alignment of responsibility
- Alignment of decisions with defined priorities
- *Having clear priorities of what type of services and processes have to be repaired before others*

Interdependencies recommendations

- *This function must be activated having in view the Coordinate Service delivery function, receiving by this function plans and coordination with other processes. It is not appropriate to start the Coordinate service delivery function before the critical emergency has finished.* A transport infrastructure in good order is a precondition of the transport service restoration.
- Appropriate funding and an accurate strategic plan are needed to operate correctly this function.
- This function must provide the highest possible feedback to Coordinate Service delivery function so that *the latter can coordinate the normal activities.* This can be performed by direct communication or by monitoring continuously the repair operations. This function must also communicate with Manage awareness & usage behaviour function so that there is awareness about status of services and processes.
- *It's strongly recommended that this function should coordinate with Restore/repair physical infrastructure function.* In particular it is necessary to share operation plans and carefully coordinate restore timing plans. Also human resources can be optimized to repair/restore both infrastructures and services/processes. It is obviously necessary that a service must be restored after the infrastructures on which it depends are restored and checked. Capacitated trained personnel with work experience must be involved. Furthermore, clear roles and responsibilities of the field & management personnel have to be assigned in advance, as well as the responsible body to give permission to start operations.
- To increase resilience, following restore/repair operation activities, it is also important that all data regarding the restoring operation become available to those who collect information about the incident.
- During the repair operations function, the current laws and standards about safety risk must be taken into account. It’s strongly recommended to restore the community services and processes to their previous condition avoiding reproducing their previous hazard vulnerability.
- A pre-event recovery plan prioritizes transport services (links & nodes) to be restored. A target for the said function is 90% operability in the short-/mid- term. A dynamic KPI is the time needed up to 90% operability. A static resilience KPI measures the transport demand covered by alternate carriage capacity as percentage of the transport demand reduction due to the disruption.

Limitations

- Possible limited financial resources
- Possible contracts limitations between institutions and private companies (non existence of SLAs)
- Possible resistance to allocate more money to avoid hazard vulnerability in future
- Possible lack of infrastructures where to place alternative services and procedures

Examples

Attiko Metro (AM) line closure after malevolent attack – Athens, Greece

- A disruption to the Athens metro service due to attacks is simulated with the Strategic Transport Model of AM. UTS resilience is assessed in cases of no transit alternative vs. bus bridging. Static resilience KPIs have been estimated.

National Response Framework (NRF) - USA

- This is a guide to how the U.S. Nation conducts all-hazards response. It is built upon scalable, flexible, and adaptable coordinating structures to align key roles and responsibilities across the Nation, linking all levels of government, nongovernmental organizations, and the private sector. It is intended to capture specific authorities and best practices for managing incidents that range from the serious but purely local, to large-scale terrorist attacks or catastrophic natural disasters. http://www.fema.gov/pdf/emergency/nrf/nrf-core.pdf (Mar. 24, 2016)

National Disaster Recovery Framework (NDRF) - USA

- It describes the concepts and principles that promote effective Federal recovery assistance in U.S. It identifies scalable, flexible and adaptable coordinating structures to align key roles and responsibilities. It links local, State, Tribal and Federal governments, the private sector and nongovernmental and community organizations that play vital roles in recovery. The NDRF captures resources, capabilities and best practices for recovering from a disaster (localized or at large scale).

4.4 Learn

4.4.1 Collect event information

Background facts

When a disruptive event impacts a UTS, it generates “effects” at different levels which could be monitored – and hopefully controlled during the emergency management – through ICT systems or information reported by operators, travellers and, more generally, citizens.

The collection of information and data related to disruptive events are therefore crucial to enable the definition of good practices and the identification and evaluation of actions supporting a quick recovery to normality as well as adaptations needed to increase the overall resilience of the UTS to disruptive events.

As any other organization, a company managing UTS works with three classes of knowledge: *tacit* knowledge, *rule-based* knowledge, and *background* knowledge. Tacit knowledge consists of the hands-on skills, special know-how, heuristics, intuitions, and the like that people develop as they immerse in the flow of their work activities; *rule-based knowledge* is explicit knowledge that is used to match actions to situations by invoking appropriate rules; and, finally, *background knowledge* is part of the organizational culture and is communicated through stories, metaphors, analogies, visions, and mission statements. Thus, a dedicated information/knowledge management is necessary to formalize, consolidate and make easy-to-share the relevant knowledge.

The basic goal of information management is to harness the information resources and information capabilities of the organization in order to enable the organization to learn and adapt to its changing environment.

Many ICT systems and platforms are generally used to constantly monitor the current condition and the level of service of an UTS, both at cyber and physical level, and support the evaluation of possible risks. Other ICT solutions are employed, during the emergency management, often requiring a high level of integration/interoperability with monitoring and control systems generally used during the normal operations. Moreover, in many cases, the ICT solutions adopted during the emergency management also require integration/interoperability with monitoring and control systems of other critical infrastructures – interconnected to the UTS – as well as across the different stakeholders involved in the operations.

All these ICT systems, platforms and solutions usually allow to collect and store in-home data (usually structured) which can be stored to be analysed – ex-post – in order to better understand the features of the event, its impact and the effectiveness of the current guidelines and good practices.

However, a huge amount of external information is usually lost, even if it could be extremely relevant to deeply understand, model and analyse the event and evaluate the current resilience of the UTS. Any event is characterized by a multi-domain and multi-level nature, involving not only ICT systems and operators but also citizens, who can be users of the UTS or more generally people staying in the city and affected by the disruptive events occurred – and propagated – in the UTS.

In UTS, commuters, citizens and tourists are users of the transportation service, representing different modalities of response to a disruption (i.e., contrary to tourists, both commuters and citizens have a better knowledge about the overall transportation network of the city and it is easier, for them, to “adapt” their mobility choices to mitigate the impact of the event on their daily life activities).

People involved in the event can for sure provide a lot of information which can complete the data and information collected through ICT systems and reported by the operators, respectively. It is important to highlight that in some cases the “human/social sensing” could be the only solution to collected information (e.g. about a specific area not covered by monitoring systems and not yet reached by the emergency management operators).

The critical issue associated to this function is related to the modifications which may occur over time and affecting ICT systems used at every level: to monitor and control the UTS, to coordinate, monitor and support the operations during the emergency management, to collect and store relevant information reported by the users of the transport service – or citizens in general – usually defined as “user generated contents”.

General Recommendations

- Establish a knowledge base, at organization level, to collect and record ongoing operational data
- Identify informational needs at UTS organization level. The identification of informational needs should be sufficiently rich and complete in representing and elaborating travellers' needs. Since information usage usually takes place in the context of a task or problem situation, specific informational needs require to be elicited from individuals. Unveiling informational needs is a complex and fuzzy communication process. Understanding informational needs requires to place those needs in the real-world context in which the person experiences them and to observe and analyse how the person use information to take actions.
- Information acquisition tries to balance two opposite requirements. On the one hand, the informational needs of the UTS organization are wide-ranging, reflecting the breadth and diversity of its concerns about changes and events in the external environment. On the other hand, human attention and cognitive capacity is limited so that the organization is necessarily selective about the information to examine. Thus, the set of information source used to monitor the environment should be sufficiently large and various to reflect the span and sweep of the UTS organization's interests. Although this suggests that the organization would activate all the available human, textual and online sources, the information variety must be controlled and managed, in order to avoid information saturation. An effective approach for managing information variety is to involve as many persons of the UTS organization as possible in the information gathering process.
- Human sources are among the most valued by people at all levels of the UTS organization: human sources filter and summarize information, highlight the most salient elements, interpret ambiguous aspects, and in general provide richer, more satisfying communication about an issue. Information acquisition planning should therefore include the creation and coordination of a distributed network for information collection.
- An adaptive UTS needs to be able to find the specific information that best answer a query, and to collate information that describes the current state and recent history of the UTS. Well integrated archival policies and records management systems will enable the organization to create and preserve its corporate memory and learn from its history.
- The system should capture hard and soft information, support multiple user views of the data, link together items that are functionally or logically related, permit users to harvest the knowledge that is buried in these resources, and so on. Because the same information can be relevant to a range of different problem situations, it becomes necessary to represent and index the unstructured information according to many criteria.

Common Conditions recommendations

1. Availability of resources

Humans (labour) – skills/competence

- At the heart of the organization are four groups of experts who need to work together as teams of knowledge partners: the domain experts; the information experts; and the information technology experts:
  - Domain experts are individuals in the organization who are personally engaged in the act of creating and using knowledge;
  - Information experts are the individuals in the organization who have the skills, training and know-how to organize knowledge into systems and structures that facilitate the productive use of information and knowledge resources;

  - The information technology experts are the individuals in the organization who have the specialized expertise to fashion the information infrastructure of the organization. The information technology experts include the system analysts, system designers, software engineers, programmers, data administrators, network managers, and other specialists who develop computer-based information systems and networks.
- Skill and competences involved in this function are really different and multi-domain. Personnel of the UTS, who is in charge to internally cooperate to the emergency management, has to be trained in order to effectively support emergency management operators and guarantee cooperation and information sharing even beyond the current integration/interoperability of the ICT systems and solutions.
- Furthermore, psychologists as well as human and social science experts should cooperate to support users of the UTS, in particular frequent users such as commuters, and citizens involved in the event in reporting information which could be useful in order to comprehensively understand the nature and characteristics of the event and the effectiveness of the overall response performed.
- Finally, technological competences and skills are strictly required to allow the storage of all the data and information collected in a multi-domain and multi-level knowledge base which can be then used for supporting an ex-post analysis based on both historical and updated data and information. Technological competences and skills are also required in order to assure – hopefully improve – the level of integration/interoperability between different ICT systems, even along their own evolution.

Budget

- Financial reserves to be accessed for acquiring new ICT systems as well as to update those currently used with the aim to improve data and information collection, storage, integration and sharing.

Data & Algorithm

- Data coming from all the ICT systems used to monitor and control the UTS (also during the emergency management), regarding the trends of values to be monitored from the city and the decision and actions taken from the intelligent transport systems and other control rooms.
- Data coming from all the ICT systems used by the emergency management operators.
- Data/information collected through “social/human sensors” during the emergency (mainly users affected by the event).
- Data/information collected through “social/human sensors” after the emergency (both users involved in the event and citizens in general).
- Data warehousing and Big Data management (both structured and unstructured data).
- Data/Information Fusion.
- Data registered from the cameras have to be saved and not left on the system that typically performed periodic overwriting.

2. Training and experience

- Technological skills to store and integrate data from different sources and in different formats (Big Data, Information/Data Fusion, Data Warehousing).
- Psychology and human/social science skills to retrieve relevant and trustworthy information about the event from users/citizens involved in the event.
- Cooperation skills to support and facilitate the collection and sharing of relevant information.

3. Quality of communication

- Guarantee communication channels which may work as a backup in case of emergency in order to ensure data/information sharing among different systems and stakeholders during the emergency management.

- Guarantee the correct communication with the users/citizens involved in the event – by involving psychology and social/human science experts – to collect useful and right information in order to improve understanding about the event and the current resilience capabilities of the system.
- Communication with other interconnected CIs

4. Human Computer Interaction and operational support

- Several human-computer interactions during the emergency management, according to the different ICT systems used and the cooperation among operators
- Data/information input and storage to enable retrieval, visualization, correlation and analysis after the event

5. Availability of procedures and plans

- It is important to have already defined, and in case updated, procedures and plans regarding the cooperation between critical infrastructure and other emergency operators, in particular with respect the data and information sharing/integration goals

6. Conditions of work

- Provide legislation to ensure the cooperation among different stakeholders and storage of shared data/information into a comprehensive knowledge base

7. Number of goals and conflict resolution

- A detailed report of the data and information collected and stored regarding the event
- A detailed report of the updated (new) data and information into the knowledge base
- Increasing the level of knowledge related to events, their specific impacts and the relations with the overall "environment" (features of the CI, number and types of interconnected Cis, procedures, ICT systems involved, actions, etc.)

8. Available time and time pressure

- Personnel must be trained: hands-on training sessions should be performed
- Technical personnel must be trained to support and keep up-to-date the procedure for data and information integration/fusion
- Timeliness of data

9. Circadian rhythm and stress

- There must be specific psychological skills to support the collection f information from users/citizens that could be under stress due to the event.

10. Team collaboration quality

- High quality is required, in particular among technical personnel of critical infrastructure and emergency stakeholders
- Involvement of psychology and social/human science experts as to take into account characteristic of both event and critical infrastructure in order to acquire useful information from what users/citizens report

11. Quality and support of the organization

- Clear plan for cooperation and information sharing with other relevant stakeholders (emergency management operators and human/social science experts

Interdependencies recommendations

- Interdependencies are related to the different data sources, more precisely internal ones, which have to be considered in order to increase the level of knowledge about events, features of the UTS and possible impacts. Data are related to different actors and technological systems involved during all the phases of the prepare-absorb-recover-adapt process.
- To maximise the internal data availability, a dedicated procedure, wide information and a specific ICT infrastructure should be put in place to favourite data transfer from different functions.

Limitations

- Post-event stress could make difficult to collect reliable and consistent information about the event from involved citizens/users

Examples

- B. Hardjono, A. Wibisono, A. Nurhadiyatna, I.Sina and W. Jatmiko "Virtual Detection Zone in smart phone, with CCTV, and Twitter as part of an Integrated ITS", International Journal On Smart Sensing And Intelligent Systems Vol. 6, No. 5, 2013.

This paper presents many experiments that have been conducted with the aim to evaluate the possibility to integrate different sources of data to obtain information on flows in an Information Transport System. The role of new smart/personal technologies and social media, along with and traditional ICT systems for UTS monitoring and control, is reported, with a specific focus on the possibility to integrate different sources to achieve a more comprehensive information.

4.4.2 Provide adaptation & improvement insights

Background facts

The complexity of interconnected systems, such as UTS, requires a deep analysis of the possible responses to events. Furthermore, the highly dynamic behaviour – associated with the operations during and after the event, as well as the occurrence of "new" types of event – makes more difficult to model "a-priori" the possible response. This is even more relevant where citizens are deeply involved, such as commuters and tourists using the UTS.

According to these considerations, the need to learn, directly from data, becomes crucial. Ex-post analysis, considering the nature and features of the event, the operations performed (and their timing), as well as the comparison with good practices, permits to identify criticalities/vulnerabilities and, subsequently, define corrective actions to improve the adaptation of the UTS to similar events.

The "response" of people to an event, specifically travellers using the UTS, both commuters who well known the urban transportation network and tourists who might do not know it very well, is a phenomenon characterized by a certain level of chaos, depending on concurrent/antagonist individual behaviours, current level of demand and supply, provisioning of right information at right time to reduce time needed to come back to a stable condition.

Data availability is therefore important for improving the capabilities to infer and model the behaviour of the UTS and simulate the expected impact of alternative corrective actions, even with respect to other types of events.

One relevant "unstructured" data source is related to social media and the contents generated by users, both travellers involved in the disruptive event as well as citizens who may indirectly affected. These sources of information allow for monitoring and characterizing the response of people to different events occurring at different time.

General recommendations

Ordinary stresses as well as emergency situations need to be analysed. The most intrinsic robustness of an UTS comes from continuous listening to the public, both the commuters and the occasional visitors. The former provides information useful to learn and adapt the system inefficiencies, also providing suggestions for long term ameliorations. The latter provides immediate feedback, and because they don't know the UTS, they may suggest fast, short term ameliorations, in communications, signalling, ticketing, availability and quality of comforts.

After having listened to the people, conducted exercises, and eventually after a real emergency have been resolved, it should be enacted continuous debriefing, circulate the results for review and provide summaries to information exchanges. Feedback must be shared with other UTS with the aim to enforce the diffusion of good practices. When considering the relevant adaptation options, the following should also be considered:

- when it is necessary to make actions and why,
- what level of adaptation is required
- which is the suitable level of adaptation, considering the consequences of over- and under- adaptation.
- establish an internal "System Thinking" perspective focusing on a holistic rather than a reductionist view of the UTS
- Learning and Adaptation objectives should incorporate the total human beings with all the persons' intellectual and spiritual assets.
- Consider the Environmental Impact Assessment (EIA) as an appropriate instrument to mainstream adaptation, helping to improve the climate resilience of infrastructure. The Environmental Impact Assessment (EIA) is a procedural and systematic tool that is in principle well suited to incorporate

considerations of climate change impacts and adaptation within existing modalities for project design, approval, and implementation. The EIA Directive requires that environmental impact assessments shall identify, describe and assess the direct and indirect effects of a project on the human beings, fauna and flora, soil, water, air, climate, the landscape, material assets and cultural heritage and the interactions between these factors

- While adaptation challenges differ from sector to sector, the ongoing adaptation process also includes several common elements across the sector. Adaptations of critical infrastructure, and therefore also UTS, with respect to changing climate needs to be considered in two ways:
    a) when a new infrastructure is built, resilience to climate changes can be ensured by locating, designing and operating an asset with the current and future climate in mind. This is particularly important in the case of large infrastructure which usually has a lifespan of at least 20 years and, therefore, investment decisions influence future generations' wellbeing,
    b) existing infrastructure can be made more resilient to climate changes by retrofitting and/or ensuring that maintenance regimes incorporate suitable adaptations over an asset's lifetime.

- Achieve sector and location specific resilience to climate change, there is a need for a thorough and coherent assessment of local climate impacts – based on historical records, but also including projections on future climatic conditions.
- Promote the creation and participation to a Trusted Information Sharing Network as a forum in which the owners and operators of critical infrastructure work together and share information on threats and vulnerabilities and develop strategies and solutions to mitigate risk.
- Define a Critical Infrastructure Program for Modelling and Analysis (CIPMA), a computer-based capability which uses a vast array of real data and information from a range of sources (internal and external) to model and simulate the behaviour and dependency relationships of critical infrastructure systems. CIPMA uses an all hazards approach to undertake computer modelling to determine the consequences of different disasters and threats (human and natural) to critical infrastructure. Owners and operators of critical infrastructure can use this information to prevent, prepare for, respond to or recover from a natural or human-caused hazard.

Common Conditions recommendations

1. Availability of resources

Humans (labour) – skills/competence

Several stakeholders have to be involved in the debriefing activities:

- Technical/methodological experts for implementing and analyzing the "what-if" simulation scenarios with respect to current and adapted UTS.
- Experts in communication to translate simulation findings into proposals for the management.
- All the actors involved in the emergency coordination and management should provide information about performed actions, features of the event and the environment, behaviour of the people involved in the event and their response.
- Experts who can provide updated knowledge about good practice and support ex-post comparison and analysis.
- UTS users involved in the event, commuters and tourists as well as citizens are directly affected by the event (e.g. by its propagation).

Budget

- Adaptation might require relevant investment. To secure such investment, the role of insurance of financial reserves to be accessed for setting the de-briefing activity up is crucial.

Data & Algorithm
- All the data acquired through monitoring systems
- All the data related to other historical events
- All the information collected and reported from actors involved in the event
- Good practices
- Network modelling and simulation algorithms
- Data Mining algorithms
- What-if simulation algorithms

2. Training and experience
- Data analysis, network analysis and software simulation to analyse and evaluate UTS and possible adaptations
- Management and coordination skills to collect and share information, manage the debriefing and support analysis and discussion
- Good practice experts

3. Quality of communication
- Guarantee a complete and clear share of knowledge, data and information among the different actors
- Guarantee the understanding of the possible advantages and impacts produced by the discovered insights and provided adaptation actions.

4. Human Computer Interaction and operational support
- Utilization of software tools to analyse data.
- Utilization of social networks to collect data and information about the opinion and sentiment of citizens/people with respect to the event, the emergency management and the recovery actions.
- Utilization of software tools to model rules of the system – even "new" ones, discovered through the ex-post analysis of the event.
- Utilization of software tools to simulate "what-if" scenarios in the interconnected system and obtain (synthetic) data.
- Utilization of software tools to analyse the impact of adaptation strategies which could be applied to the system, also supporting the evaluation socio-economic cost-benefit.

5. Availability of procedures and plans
- Planning process to effectively implement the proposed adaptations: working groups' management and economic/financial analysis for priorizing adaptation actions

6. Conditions of work
- The cooperation among the different stakeholders during the debriefing activities, the analysis and the definition of insights and adaptations should be facilitated. Cooperation is related to sharing of data, information and evaluation at every level and multi-domain: social, economic, technological, infrastructural and service.

7. Number of goals and conflict resolution

- Quantitative and qualitative measures about the expected impact of the application of the defined adaptations (e.g. reduction of risk with respect to similar past events as well as events occurred in different geographical areas).

8. Available time and time pressure
   - Medium/long term goals related to the reduction of risk and possible impacts of disruptive events, even if analysis should be performed in the very short-time after the event in order to guarantee the collection and analysis of data and information which are not stored into ICT systems.
   - Adaptations can be related to different levels and domains, thus different times can be required to implement adaptation actions, even according to budgetary constraints

9. Circadian rhythm and stress
   - N.A.

10. Team collaboration quality
    - Collaboration and cooperation are crucial for accurately address the analysis of data and information, the definition of adaptations and the evaluation of their potential impact.

11. Quality and support of the organization
    - Clear decision making process and alignment of responsibility
    - Planning operations to implement adaptation of the overall system, according to budgetary constraints
    - Procedures improved to effectively prevent and mitigate events, according to collected data, information and results from what-if simulation
    - Overall targets: increasing knowledge about the impact of events, reducing vulnerabilities of the system, improving effectiveness of the response
    - The collected knowledge improves the resilience of the overall system and may also be shared to support resilience improvements also to other critical infrastructures

Interdependencies recommendations

- An effective adaptation can be only identified by considering relevant data about the event and possible budgetary constraints.
- The current status of the cyber physical infrastructure associated to the UTS as well as the usage behaviour have also to be known in order to define the most suitable adaptation actions. Usage should be analysed according to local specificities and with respect to different “modalities” (e.g. commuters or tourists) at different time scales (e.g. period of the year, days of the week, hours of the day)
- Finally, all the information related to the service provisioning has to be deeply evaluated to estimate the possible variations of the level of service associated to the adaptation actions and improvement insights identified.

Limitations

- Costs for the “optimal” adaptations could be too high, making difficult their implementation – priorization of actions can facilitate the implementation of the most critical adaptations
- Unavailability / late availability of data

Examples

Responding to climate impacts: railways between Copenhagen and Ringsted (DK)

Increased precipitation and increased water flow in watercourses can affect the new railway line between Copenhagen and Ringsted. In connection with the project on expanding the track capacity between Copenhagen and Ringsted on Zealand, the Public Transport Authority, which has analysed the track capacity, has carried out a climate change impact assessment for the project. The goal of the impact assessment is to investigate a future rail track's robustness to climate change over a 100-year operating period. The assessment shows that especially increased precipitation and increased water flow in watercourses can impact on railway constructions, whilst other factors such as increasing temperatures, rising sea levels and rising groundwater will not have a significant impact. Of particular importance is an expected 20% increase in the intensity of rainfall in heavy downpours in the year 2100. In areas where watercourse crosses the track, under a bridge or tunnel, climate changes mean there is a risk that water cannot flow quickly enough and thereby build up and Risk eroding the railway construction. Therefore, a new track between Copenhagen and Ringsted will have a 30 per cent greater capacity for water flow than the norm that is used at present. The Public Transport Authority assesses that the recommendations for adaptation to climate change are robust in relation to the variations in the expected climate changes.

4.5 Cross CI-Interdependencies

Due to the complex nature of UTS and its critical position in the overall social and economic system, there are numerous interdependencies with other sectors, even within the system itself.

UTS is actually composed of a number of sub-systems which operate independently but highly interconnected. Each transport mode for instance can be considered as a different sub-system, to which all system-related ERMG guidelines also apply, even in a smaller scale than for the whole UTS. Thus, all these sub-systems should cooperate for the optimal operation of the overall UTS.

Apart from these “internal” interdependencies, UTS is actually interacting with almost any other critical system. From energy and communications, to health facilities and any kind of industry (including dangerous materials), dependencies and interdependencies to the UTS are strong and critical for the operation of all these systems and for establishing a resilient environment.

The complexity and multitude of existing links to other systems and sectors, makes it virtually impossible to simply describe them in full detail and with all possible interactions. Thus, several methodologies and implementation examples of modelling the interconnection of transportation systems have been developed and can be found in the literature, like (Pengcheng& Srinivas, 2011), (Gomes, 1990), (Dugundji & Walker, 2014). This type of models (here only indicative examples given) can represent the interconnections of a given UTS with other critical (and not only) systems. Of course, these are case-specific and vary according to the characteristics of the system under consideration.

Following the updated generic guidelines provided in D3.6, concerning cross-sector interdependencies, for the case of UTS the following can be recommended:

- Understanding and addressing risks

In the case of UTS this implies risks deriving from dependencies and interdependencies both between sub-systems of the UTS, like, for instance, shared/interacted infrastructure between different modes and between the UTS and other sectors, like energy (transportation of fuels, energy supply for the UTS, etc.), communications (communication infrastructure interacting with transportation systems, communication services used by the UTS for its operation, etc.), health (access to health facilities, transportation of patients, etc.), dangerous materials industry (transportation of dangerous materials, especially through critical infrastructure components, like tunnels, etc.)

- Data management

An issue of utmost significance is the management of data between different systems and sectors. Data can be of different and of various types and contents, affecting at the same time one or multiple functions of each system. The use of a centralised tool at local or even at European level (like CIWIN) is absolutely necessary for the effective and smooth data distribution, fusion, storage and analysis.

- Managing cascading effects

The more the interdependencies the greater the risk of cascading effects. Thus, in the case of UTS this is an issue that should be closely looked into, through strong cooperation between systems and sectors for the in-depth analysis of the possibility of such events at different levels (in terms of localisation and magnitude). For example, there should be clear understanding and pre-decided response and mitigation actions for the case of a multi-vehicle crush in an urban highway during a severe downpour, which will definitely result in road closure, with all kinds of implications that this may infer, in order to result in the least possible disruption to the UTS and, consecutively, the overall local activities operation.

In whole, managing interdependencies between the UTS and other sectors require overall monitoring structures, which, depending on the magnitude and significance of the urban environment in question, shall be established at local, regional, national or even EU level. Such structures should be in charge for analysing existing interdependencies, ensuring the resilient operation of all systems under the given circumstances, while guaranteeing the preparedness for response in the case of disruption occurring to any of the linked systems. It is also important to establish clear communication channels between the affected organisations, through several media (online tools, workshops, etc.) to ensure understanding and cooperation at all levels of involved stakeholders.

5 CONCLUSIONS

Cities and urban areas represent dense and complex systems of interconnected services and different perspectives and level of understanding among involved stakeholders. Thus, creating resilient Urban Transport Systems requires a multidimensional perspective and approach, considering interconnections among different UTS stakeholders and activating at the same time the whole network dynamics to respond timely and effectively in emergencies.

Especially considering the emerging concept of Smart Cities, in which data sharing, ICT and IoT are basic requirements, while citizens' protection, safety and security are among the main concerns, UTS resilience against physical and cyber threats becomes a necessity.

Although, examples from recommendations given in Chapter 4, show that there is actually progress in the field of urban transport resilience, a horizontal approach with holistic guidance to avoid critical UTS emergencies is still missing.

Firstly, it is necessary to identify the drivers of urban transport risks in order to understand them and enhance UTS preparedness following the provided recommendations and towards developing transport disaster resilient systems. To do so, a proper UTS management and coordination among transport related stakeholders is needed, involving civil society and building urban alliances, while ensuring that all actors understand their role in transport risk reduction and preparedness. Towards this target some indicative prerequisites are:

- clear procedures and guidance for UTS resilience,
- budget assigned for UTS resilience management,
- maintenance of up to date data on hazards and vulnerabilities,
- guidance on prioritizing human resource and budget allocation,
- proper connectivity and communications services,
- policies,
- educational and training programs along with awareness campaigns.

By addressing UTS emergency events (based on scenarios) that arise from natural hazards or human intervention and may threaten the operations and/or physical infrastructure of the UTS, the aim is to create sufficient capacities to deal with these emergencies. When it comes to anticipating, managing and/or reducing actual or potential risks, guidance is needed for setting up and/or acting based on early warning systems and establishing specific UTS crisis management structures.

This deliverable provides guidance and recommendations considering all the above and insights to establish the proper resilient UTS organizational and monitoring framework for European resilient transport systems and European urban areas liveable and sustainable. It is an updated version of D3.7 issued in M12 of RESOLUTE project, including improved recommendations, following the results of the project pilots and Advisory Board, as well as the commonly updated generic ERMG (D3.6). Moreover, a short, practical and comprehensive version of the guidelines has also been produced (Annex A), to facilitate the dissemination and exploitation of the guidelines to all interested parties.

6 REFERENCES

Bibliography

AEMC, 2002. National Good Practice Review of Public Awareness, Education and Warnings in Emergency Management - High Level Group of the COAG Review of Natural Disaster Relief and Mitigation Arrangements, Australian Emergency Management Committee ,unpublished draft

Natvig B.,2011. "Measures of component importance in nonrepairable and repairable multistate strongly coherent systems," Methodology and Computing in Appl. Probabil., vol. 13, no. 3, pp. 523–547, 2011

Adjetey-Bahun K., Birregah B., Châtelet E, Planchet J-L.,2016. A model to quantify the resilience of mass railway transportation systems, Reliability Engineering and System Safety 153 (2016) 1–14

Adjetey-Bahun K., Birregah B., Chatelet E., Planchet J.-L., 2014. A simulation-based approach to quantifying resilience indicators in a mass transportation system. In: Proceedings of the 11th international ISCRAM conference, University Park, Pennsylvania; 2014

AG,2011. Organizational Resilience. Australian Government position paper (2011). ISBN: 978-1-921725-62-3, Available online:< http://www.emergency.qld.gov.au/publications/pdf/organisational_resilience.pdf>

Albert R, Barabási AL., 2002. Statistical mechanics of complex networks. Rev Mod Phys 2002;74:47–97

Alexander, David E., 2014. "Social media in disaster risk reduction and crisis management." Science and engineering ethics 20.3 (2014): 717-733.

APCICT , 2010. Communication Technology for Development (APCICT), ICTD Case Study 2, May 2010

Ash J, Newth D., 2007. Optimizing complex networks for resilience against cascading failure. Phys: Stat Mech Appl 2007;380:673–83

Ash J, Newth D., 2011. Optimizing complex networks for resilience against cascading failure. Physica A: Stat Mech Appl 2007;380:673–83; | Ip W, Wang Q. Resilience and friability of transportation networks: evaluation, analysis and optimization. IEEE Syst J 2011;5(2):189–98

ASME, 2009. Innovative Technological Institute (ITI). American Society of Mechanical Engineers (ASME). Washington, D.C.: ASME ITI, LLC; 2009.

Asprone, D., Cavallaro, M., Latora, V., Manfredi, G., Nicosia, V., 2013. "Assessment of urban ecosystem resilience using the efficiency of hybrid social-physical complex networks", in Computer-aided Civil and Infrastructure Engineering 29, February 2013

Australian Government,2010. Critical Infrastructure Resilience Strategy, Commonwealth of Australia, ISBN: 978-1-921725-25-8

Avvenuti, Marco, et al., 2015. "Pulling information from social media in the aftermath of unpredictable disasters." 2nd international conference on information and communication technologies for disaster management (ICT-DM). 2015.

Baroudi, B., & Rapp, R., 2013. Disaster Restoration Projects: A Conceptual Project Management Perspective. In Australasian Journal of Construction Economics and Building-Conference Series (Vol. 1, No. 2, 72-79).

Bevan, N., 1995. Human-Computer Interaction Standards. In Anzai & Ogawa (eds.). Proceedings of the 6th International Conference on Human Computer Interaction, Yokohama, July 1995, Elsevier.

Bevan, N.,1995. Human-Computer Interaction Standards. In Anzai & Ogawa (eds.). Proceedings of the 6th International Conference on Human Computer Interaction, Yokohama, July 1995, Elsevier.

Boccaletti S., Bianconi G., Criado R., del Genio C. I., Gmez-Gardees J., Romance M., Sendia-Nadal I., Wang Z., Zanin M.,2014. The structure and dynamics of multilayer networks, Phys. Rep. 544, 1, 2014

Brown, K., 2015. Global environmental change I: a social turn for resilience? Prog. Hum. Geogr. 38, 107–117 (2014)

Brown, K.,2014.: Global environmental change I: a social turn for resilience? Prog. Hum. Geogr. 38, 107–117 (2014)

BS OHSAS 18001 - Occupational Health and Safety Management (OHS), OHSAS 180001 http://www.bsigroup.com/en-GB/ohsas-18001-occupational-health-and-safety/>

BSI, 2014. Guidance on organizational resilience, ISBN 9780580779497

Bush et al, 2005. Critical Infrastructure Protection Decision Support System –Intentional System Dynamics Conference 2005

Cardillo A., Zanin M., Gómez-Gardeñes J., Romance M., García del Amo A. J., Boccaletti S.,2013. Modeling the multi-layer nature of the european air transport network: Resilience and passengers re-scheduling under random failures, Eur. Phys. J. Spec. Top. 215, 23, 2013.

Caschilli, S., Medda, F.R., Wilson, A., 2015."An Interdependent Multi-Layer Model: Resilience of International Networks", Netw Spat Econ (2015), 15, 313-335.

CGI,2013. "Developing a Framework to Improve Critical Infrastructure Cybersecurity", 2013

Chen A, Yang C, Kongsomsaksakul S, Lee M., 2014. Network-based accessibility measures for vulnerability analysis of degradable transportation networks. Netw Spat Econ 2007;7(3):241–56). (Ouyang M, Zhao L, Hong L, Pan Z. Comparisons of complex network based models and real train flow model to analyze chinese railway vulnerability. Reliab Eng Syst Saf 2014;123:38–46

Chen L, Miller-Hooks E., 2012. Resilience: an indicator of recovery capability in intermodal freight transport. Transp Sci 2012;46(1):109–23

CIRS, 2010. CRITICAL INFRASTRUCTURE RESILIENCE STRATEGY, ISBN: 978-1-921725-25-8

Clay-Williams et al.2015. Where the rubber meets the road: using FRAM to align work-as-imagined with work-as done when implementing clinical Implementation Science (2015) 10:125 DOI 10.1186/s13012-015-0317-y

Conrad L. Dudek,2004. "Changeable Message Sign Operation and Messaging Handbook", Operations Office of Travel Management, ederal Highway Administration, U.S. Department of Transportation, 2004

Council of the European Union, 2008. Council Directive on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection, (2008/114/EC)

Crawford, L., Langston, C., & Bajracharya, B., 2013. Participatory project management for improved disaster resilience. International Journal of Disaster Resilience in the Built Environment, 4(3), 317-333.

Cupac V, Lizier JT, Prokopenko M., 2013. Comparing dynamics of cascading failures between network-centric and power flow models. Electr. Power Energy Syst 2013;49:369–79

CWIN, 2008. Critical Infrastructure Warning Information Network –CWIN http://ec.europa.eu/dgs/home-affairs/what-we-do/networks/critical_infrastructure_warning_information_network/index_en.htm

DARWIN Project, 2015. D1.1 Version 0.6: Consolidation of resilience concepts and practices for crisis management.

De Domenico M., Solé-Ribalta A., Cozzo E., Kivelä M., Moreno Y., Porter M., Gómez S. A, Arenas A., 2013. Mathematical Formulation of Multilayer Networks, Phys. Rev. X 3, 041022, 2013

De Domenico M., Solé-Ribalta A., Gómez S., Arenas A., 2014. Navigability of interconnected networks under random failures, Proc. Natl. Acad. Sci. U.S.A. 111, 8351, 2014

DHS, 2006. U.S. Department of Homeland Security,National Infrastructure Protection Plan, 2006. Available online at: www.dhs.gov/nipp.

DHS, 2008. NIAC Insider Threats to Critical Infrastructure Study (2008) < https://www.dhs.gov/xlibrary/assets/niac/niac_insider_threat_to_critical_infrastructures_study.pdf>

DMBC, 2010. Recovery Plan. Contingency and disaster management. Dudley Metropolitan Borough Council (2010).

Doran, G. T., 1981. "There's an S.M.A.R.T. way to write management's goals and objectives". Management Review (AMA FORUM) 70 (11): 35–36

Dorbritz R., 2011. Assessing the resilience of transportation systems in case of large-scale disastrous events. In: Proceedings of the eighth international conference on environmental engineering, Vilnius, Lithuania; 2011. p. 1070–1076

Dugundji, E., Walker, J., 2014. Discrete Choice with Social and Spatial Network Interdependencies: An Empirical Example Using Mixed Generalized Extreme Value Models with Field and Panel Effects. Transportation Research Record: Journal of the Transportation Research Board , Volume 1921, pp. 70–78

Duque, P. A. M., Dolinskaya, I. S., & Sörensen, K., 2016. Network repair crew scheduling and routing for emergency relief distribution problem. European Journal of Operational Research, 248(1), 272-285.

EC, 2012. Action Plan on Urban Mobility – State of Play, European Commission, 2012. < http://ec.europa.eu/transport/themes/urban/urban_mobility/doc/apum_state_of_play.pdf >

EEMUA , 2002. Engineering Equipment & Materials Users Association (EEMUA) Publication 201: 2002 available via EEMUA on 020 7628 7878

EmerGent, 2014. Deliverable 3.1 “usage Patterns of Social Media in emergencies”, EU-FP7-SEC project EmerGent (Emergency Management in Socia Media Generation), available at: http://www.fp7-emergent.eu/wpcontent/uploads/2014/09/D3.1_UsagePatternsOfSocialMediaInEmergencies.pdf

Environmental Impact Assessment Directive, 1985 (85/337/EEC)

Ernst &Young, 2013.ORGANISATIONAL RESILIENCE: The relationship with Risk related corporate strategies, An analysis by Ernst and Young and the Commonwealth Attorney-General’s Department.

EU, 2010. Commission Staff Working Paper 1626-2010. Risk Assessment and Mapping Guidelines for Disaster Management. The European Commission

EU, 2012. Commission staff working document on the review of the European programme for critical infrastructure protection (EPCIP), SWD (2012)190 final

EU, 2013. Commission staff working document on a new approach to the European Programme for Critical Infrastructure Protection Making European Critical Infrastructures more secure, SWD(2103)318 final

EU,2006.. Communication from the Commission on a European Programme for Critical Infrastructure Protection, COM(2006)786 final

EU,2008. Proposal for a Council Decision on a Critical Infrastructure Warning Information Network (CIWIN), COM (2008)676 final

EU,2014.Handbook on European data protection law. European Union Agency for Fundamental Rights, 2014 Council of Europe, 2014. <http://www.echr.coe.int/Documents/Handbook_data_protection_ENG.pdf>

EUROCONTROL, 2013. From Safety-I to Safety-II: A White Paper. European Organisation for the Safety of Air Navigation (EUROCONTROL) < http://www.skybrary.aero/bookshelf/books/2437.pdf>

EUROCONTROL,2014. System Thinking for Safety: Ten Principles – Moving towards Safety –II, August 2014 – European Organisation for the Safety of Air Navigation (EUROCONTROL) < http://www.skybrary.aero/bookshelf/books/2882.pdf>

Fang Y., Pedroni N., Zio E., 2016. Resilience-Based Component Importance Measures for Critical Infrastructure Network Systems, IEEE TRANSACTIONS ON RELIABILITY 2016

Fekete, A., Tzavella, K., Armas, I., Binner, J., Garschagen, M., Giupponi, C., Mojtahed, V., Pettita, M., Schneiderbauer, S., Serre, D., 2015. "Critical Data Source; Tool or Even Infrastructure? Challenges of Geographic Information Systems and Remote Sensing for Disaster Risk Governance", ISPRS Int. J. Geo-Inf. 2015, 4(4), 1848-1869.

FEMA, 2011. National disaster recovery framework: Strengthening disaster recovery for the nation. https://www.fema.gov/pdf/recoveryframework/ndrf.pdf (Mar. 24, 2016)

Ferreira, P., Simoes, A., 2015. State of the art review. RESOLUTE Deliverable 2.1.

Ferreira, P., Simoes, A., 2016. Conceptual Framework. RESOLUTE Deliverable 2.2.

FETSM, 1999. Fields of Education and Training Supplementary Manual 1999 (Statistical office of the European Communities-EUROSTAT)

Fiskel J., 2015. "Connecting with Broader Systems", Resilient by design, (2015), 191-208

Freeman L. C., 1979. "Centrality in social networks conceptual clarification,"Social Networks, vol. 1, no. 3, pp. 215–239, 1979

Freeman L. C., Borgatti S. P., White D. R.,1991. "Centrality in valued graphs: A measure of betweenness based on network flow," Social Networks, vol. 13, no. 2, pp. 141–154, 1991

FY, 2013. US. HUMAN CAPITAL MANAGEMENT PLAN. Department of Energy. http://energy.gov/sites/prod/files/2013/05/f0/OCIOWorkforcePlan.pdf.

Gaitanidou, E., Bekiaris, E., 2015. Guidelines Methodology. RESOLUTE Deliverable 3.4

Gaitanidou, E., Bellini, E., 2016. European Resilience Management Guidelines. RESOLUTE Deliverable 3.5

Gander, Philippa, et al., 2011. "Fatigue risk management: Organizational factors at the regulatory and industry/company level." Accident Analysis & Prevention 43.2 (2011): 573-590.

Gao, J., Liu, X., Li, D., Havlin, S., "Recent Progress on the Resilience of Complex Networks", Eergies 2015, 8, 12187-12210.

GFDRR, 2014. Financial Protection Against Natural Disasters, An Operational Framework for Disaster Risk Financing and Insurance, World Bank report, 2014. <https://olc.worldbank.org/sites/default/files/Financial%20Protection%20Against%20Natural%20Disasters.pdf>

Gomes, L., 1990. Modelling interdependencies among urban transportation system alternatives within a multi-criteria ranking framework, Journal of Advanced Transportation, Volume 24, Issue 1, pages 77–85, Spring 1990

Gustin, J., 2007. Safety Management: A guide for facility managers. CRC Press

Haimes YY., 2009. On the definition of resilience in systems. Risk Anal 2009;29 (4):498–501

HAZUS-MH,2004. HAZUS-MH Software Programme for Estimating Potential Losses from DisastersFederal Emergency Man. Agency, Washington, DC (2004)

Hernandez-Fajardo I, Duenas_Osorio L., 2013. Probabilistic study of failures in complex interdependent lifeline systems. Reliab Eng Syst Saf 2013;111:260–72

Hines P. and Blumsack S.,2008."A centrality measure for electrical networks," in Proc. IEEE 41st Annu. Hawaii Int. Conf. Syst. Sci., Jan. 2008, pp. 185–185

Hoegl, Martin, and Hans Georg Gemuenden, 2001. "Teamwork quality and the success of innovative projects: A theoretical concept and empirical evidence." Organization science 12.4 (2001): 435-449.

Hollnagel E.,2013. An Application of the Functional Resonance Analysis Method (FRAM) to Risk Assessment of Organizational Change. Report number: 2013:09, ISSN 2000-0456

Hollnagel, E. et al, 2013.From Safety-I to Safety-II: A White Paper EUROCONTROL 2013

Hollnagel, E., 1998. Cognitive Reliability and Error Analysis Method – CREAM. Oxford: Elsevier Science.Oedewald, P et al – Intermediate report MoReMo Modelling Resilinece for Mantainance and Outage – NKS-262 – ISBN 979-87-7893-335-5 Feb 2012

Hollnagel, E., 2004. Barriers and accident prevention. Aldershot, UK: Ashgate.

Hollnagel, E., 2009. The four cornerstones of resilience engineering. In: Nemeth, C. P., Hollnagel, E. & Dekker, S. (Eds.), Preparation and restoration (p. 117-134). Aldershot, UK: Ashgate.Ferreira, P., Simoes, A., (2016). Conceptual Framework. RESOLUTE Deliverable 2.2.

Hollnagel, E., 2014. Safety-I and Safety-II: the past and future of safety management. Ashgate

Homeland Security, 2015. National Critical Infrastructure Security and Resilience Research and Development Plan.

Hosseini S., Barker K.,. Ramirez-Marquez J. ,2016. A review of definitions and measures of system resilience, Reliability Engineering and System Safety 145 (2016) 47–61.

HSE,1997. Successful Health and Safety Management - Health and Safety Executive. Publication HS(G)65 (1997).

Hubbard, D., 2014. How to Measure Anything: Finding the Value of Intangibles in Business. Wiley.

HVHF , 2007. High Velocity Human Factor (HVHF) – High Velocity Human Factors: Human Factors of Mission Critical Domains in Nonequilibrium Proceedings of the Human Factors and Ergonomics Society Annual Meeting October 2007 51: 273-277, doi:10.1177/154193120705100427.

ICT for Disaster Risk Reduction - The Indian Experience, Ministry of Home Affairs, National Disaster Management Division Government of India

IETF, 2007. Delay-Tolerant Networking Architecture, IETF, RFC 4838 <https://tools.ietf.org/html/rfc4838>

IFRC, 2011. International Federation of Red Cross and Red Crescent Societies (2011) Public awareness and public education for disaster risk reduction: a guide

Institute of Medicine, 2002. Speaking of Health, Washington D.C., The National Academies Press.

ISDR,2006. Developing Early Warning Systems: A Checklist – International Strategy for Disaster Reduction – ISDR 2006

ISO 22301:2012, Societal security- Business continuity management systems- Requirements < http://www.iso.org/iso/catalogue_detail?csnumber=50038>

ISO 22320:2011, Societal security – Emergency management – Requirements for incident response

ISO 31000: Risk management – Principles and guidelines

Jassbi, J., Camarinha-Matos, L.M., Barata, J., “A Framework for Evaluation of Resilience of Disaster Rescue Networks”, in L.M. Camarinha-Matos et al. (Eds.): PRO-VE 2015, IFIP AICT 463, pp. 146–158, 2015.

Jenelius E., Petersen T. , Mattsson L. G. ,2006. “Importance and exposure in road network vulnerability analysis,” Transportation Res. A: Policy and Practice, vol. 40, no. 7, pp. 537–560, 2006

Johansson J, Hassel H., 2010. An approach for modelling interdependent infrastructures in the context of vulnerability analysis. Reliab Eng Syst Saf 2010;95 (12):1335–44

Jokeren, O., Azzini, I., Galbusera, L., 2015. “Analysis of Critical Infrastructure Network Failure in the European Union A combined Systes Engineering and Economic Model”, Netw Spat cEcon (2015), 15:253-270.

Kangaspunta, J., Salo, A., 2014. “A Resource Allocation Model for Improving the Resilience of Critical Transportation Systems”, (2014) available at https://www.google.it/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwix8MGiv-PLAhVIzRQKHeJwALcQFggeMAA&url=http%3A%2F%2Fsal.aalto.fi%2Fpublications%2Fpdf-files%2Fmkan14.pdf&usg=AFQjCNE-hfNMSKsL7KPFur0C92aI3vzhyg&sig2=_0m2KeH8mD_g6h4JSmLRgQ

Kappos A., Sextos, A., Stefanidou, S, Mylonakis, G. Pitsiava, M. Sergiadis, G., 2014. Seismic Risk of Inter-urban Transportation Networks. 4th International Conference on Building Resilience, Incorporating the 3rd Annual Conference of the ANDROID Disaster Resilience Network, 8th – 11th September 2014, Salford Quays, United Kingdom. In Proceedia Economics and Finance, Volume 18, 2014, pp 263.270

Karen M., 2013. Adaptive self-deployment algorithms for mobile wireless substitution networks. Networking and Internet Architecture [cs.NI]. Université des Sciences et Technologie de Lille - Lille I

Karwowski, W., 2005. Handbook of Standards and Guidelines in Ergonomics and Human Factors. New Jersey: Lawrence Erlbaum Associates, Publishers.

Kasthurirangan, Gopalakrishnan, Srinivas, Peeta, 2010. Sustainable and Resilinect Critical Infrastrucutre System A framework for Manifestation of Tacit Critical Infrastructure Knowledge: Simulation, Modelling and Intelligent Engineering - Springer 2010

Khaled AA, Jin M, Clarke DB, Hoque MA.,2015. Train design and routing optimization for evaluating criticality of freight railroad infrastructures. Transp Res B 2015;71:71–84

Kivelä M., Arenas A., Barthelemy M., Gleeson J. P., Moreno Y., Porter M. A., 2014. Multilayer networks, J. Complex Netw. 2, 203, 2014

Koc Y, Warnier M, Kooij RE, Brazier FMT, 2013. An entropy-based metric to quantify the robustness of power grids against cascading failures. Saf Sci 2013;59:126–34

Kochs, A., & Marx, A., 2009. Innovatives Instandhaltungsmanagement mit IDMVU, Leitfaden Teil 1 Überblick Gesamtprozess. Forschungsvorhaben Infrastruktur-Daten-Management für Verkehrsunternehmen (IDVMU).

Kröger W. and Zio E.,2011. Vulnerable Systems. Berlin, Germany: Springer, 2011

Kyriakides, E., Polycarpou, M.,2015. “Intelligent Monitoring, Control, and Security of Critical Infrastructure Systems”, Springer 2015, ISBN 978-3-662-44159-6

Labaka, L., Hernantes, J., Sarriegi J.M.,2016. “A holistic framework for building critical infrastructure resilience”, Technological Forecasting & Social Change, 103, (2016), 21-33.

Latora V. and Marchiori M., 2007. “A measure of centrality based on network efficiency,” New J. Phys., vol. 9, no. 6, p. 188, 2007

Lazari, A., 2014. “European Critical Infrastructure Protection”, Springer Cham Heidelberg New York Dordrecht London, 2014.

Lindell, M. K., 2013. Recovery and reconstruction after disaster. In Encyclopedia of natural hazards (pp. 812-824). Springer Netherlands.

Macdonald, J, 1998. Primary Health Care, Medicine in its place. London: Earthscan Publications Ltd

Merk, O., 2014, “Metropolitan Governance of Transport and Land Use in Chicago”, OECD Regional Development Working Papers, 2014/08, OECD Publishing. http://dx.doi.org/10.1787/5jxzjs6lp65k-en

Mucha P. J., Richardson T., Macon K., Porter M. A, Onnela J.-P.,2010. Community structure in time-dependent, multiscale, and multiplex networks, Science 328, 876, 2010

Nagurney A, Qiang Q., 2007.A network efficiency measure for congested networks. Europhys Lett 2007;79; | Nagurney A, Qiang Q. Robustness of transportation networks subject to degradable links. Europhys Lett 2007;80

NATO,2012. RTO Technical Report TR-SAS-059 Human Resources (Manpower) Management < http://natorto.cbw.pl/uploads/2012/2/$$TR-SAS-059-ALL.pdf>

NCHRP, 2013. A Pre-Event Recovery Planning Guide for Transportation, TRB report, WASHINGTON, D.C. 2013<https://www.massport.com/media/266266/Report_A-Pre-Event-Recovery-Planning-Guide-for-Transportation-2013.pdf >

NCIS, 2015. National Critical Infrastructure Security and Resilience Research and Development Plan-NCIS R&D. USA Homeland Security 2015

Newman M. E.,2005. "A measure of betweenness centrality based on random walks," Social Networks, vol. 27, no. 1, pp. 39–54, 2005

Newman M.,2010. Networks: An Introduction Oxford University Press, New York, 2010

NIAC, 2009. National Infrastructure Advisory Council (NIAC) Critical Infrastructure Resilience Final Report and Recommendations 2009

NIAC, 2014. Critical Infrastructure Security and Resilience National Research and Development Plan. National Infrastructure Advisory Council (2014)

Nicholson C., Barker K., Ramirez-Marquez J.,2016. Flow-based vulnerability measures for network component importance: Experimentation with preparedness planning, Reliability Engineering and System Safety 145 (2016) 62–73

Nieminen J., 1974."On the centrality in a graph," Scandinavian J. Psychol., vol. 15, no. 1, pp. 332–336, 1974

NIPP, 2013. Partnering for critical infrastructure security and resilience. USA: Homeland Security 2013

NORC, 2013. The Associated Press-NORC Center for Public Affairs Research (2013) Communication during disaster response and recovery.

NRF, 2008. National Response Framework. United States Department of Homeland Security. (2008). <http://www.fema.gov/pdf/emergency/nrf/nrf-core.pdf >

O'Neil LR et.al, 2015. US DOE - SPSP Phase III Recruiting, Selecting, and Developing Secure Power Systems Professionals: Behavioural Interview Guidelines by Job Roles < http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-24140.pdf>

OECD, 2013. Disaster Risk Financing in APEC Economies, Practices and Challenges <https://www.oecd.org/daf/fin/insurance/OECD_APEC_DisasterRiskFinancing.pdf>

OECD, 2014. Guidelines for resilience systems analysis, OECD Publishing

Omer M, Mostashari A, Lindemann U.,2014. Resilience analysis of soft infrastructure systems. Procedia Comput Sci 2014;28:565–74

OSHAS 18001:1999. Occupational health and safety management systems. Specifications.

Ouyang M, Duenas-Osorio L. , 2014. Multi-dimensional hurricane resilience assessment of electrical power systems. Struct Saf 2014;48:15–24

Ouyang, M.,2014. "Review on modelling and simulation of interdependent critical infrastructure systems", Reliability Engineering and System Safety, 121, (2014), 43-60.

PAHO, 2009. Information management and communication in emergencies and disasters: manual for disaster response teams. Pan American Health Organization (2009).Washington, D.C.

Pengcheng Z., Srinivas P., 2011. A generalized modeling framework to analyze interdependencies among infrastructure systems. Transportation Research Part B: Methodological, Volume 45, Issue 3, March 2011, Pages 553–579

Peter O'Neill, 2004. Developing A Risk Communication Model to Encourage Community Safety from Natural Hazards –State Emergency Service, JUNE 2004

Pollack, L.J., Simons, C., Romero, H. and Hausser, D., 2002. "A Common Language for Classifying and Describing Occupations: The Development, Structure, and Application of the Standard Occupational Classification", Human Resource Management, Vol. 41, No. 3, pp. 297-307, Fall 2002.

Pregenzer A.,2011. Systems resilience: a new analytical framework for nuclear nonproliferation. Albuquerque, NM: Sandia National Laboratories; 2011

Queensland Government, 2013. Queensland 2013 Flood Recovery Plan for the events of January– February 2013. <http://www.statedevelopment.qld.gov.au/resources/plan/local-government/lg-flood-recovery-plan.pdf>

Ramachandran, V., Long, S., Shoberg, T., Corns, S., & Carlo, H., 2016. Post-disaster supply chain interdependent critical infrastructure system restoration: A review of data necessary and available for modelling. Data Science Journal, 15.

Reggiani A., 2013. Network resilience for transport security: some methodological considerations. Transp Policy 2013;28:63–8

Richard A. Caralli, Julia H. Allen, David W. White., 2011. "The CERT resilience management model : a maturity model for managing operational resilience", ISBN 978-0-321-71243-1, Pearson Education, 2011

Rodriguez-Nunez E, Garcia-Palomares JC., 2014. Measuring the vulnerability of public transport networks. J Transp Geography 2014;35(1):50–63

Rodrigue, J-P *et al,*.2017.The Geography of Transport Systems. Hofstra University, Department of Global Studies & Geography, http://people.hofstra.edu/geotrans.

Sabidussi G., 1994. "The centrality index of a graph," Psychometrika, vol. 31, no. 4, pp. 581–603, 1966

Schupp, B.A., Zaccardo, A., Nordvik, J.-P. ,2006. Estimation Of Incidence Of Terrorist Attacks Involving Road Transport Based On Open Source Data, Institute for the Protection and Security of the Citizen, EUR 22472 EN

SEI, 2010. Strategic Planning with Critical Success Factors and Future Scenarios: An Integrated Strategic Planning Framework Linda Parker Gates November 2010, TECHNICAL REPORT CMU/SEI-2010-TR-037 ESC-TR-2010-102

Shah, J., 2009. Supply chain management: text and cases. Pearson Education India.

Sheffi Y., 2005. The resilience enterprise: overcoming vulnerability for competitive enterprise. Cambridge, MA: MIT Press; 2005.

Simon, H.A.,1979. Rational decision Making in business organization. American Economic Review 69 (4), 493-513 (1979)

Sodhi, M., Tang, C., 2012. Managing Supply Chain Risk. Springer

Solé-Ribalta A., Gómez S., Arenas A.,2016. Congestion Induced by the Structure of Multiplex Networks, Physical Review Letters 116, 108701, 2016

Staal, Mark A., 2004. Stress, Cognition, and Human Performance: A Literature Review and Conceptual Framework. NASA/TM—2004–212824. Ames Research Centre Moffett Field, California 94035. Website: http://human-factors.arc.nasa.gov/flightcognition/Publications/IH_054_Staal.pdf

Sterbenz JPG et al., 2010. Resilience and survivability in communication networks: strategies, principles, and survey of disciplines. Comput Netw 2010;54:1245–65

Stergiopoulos G., Kotzanikolaou P., Theocharidou M., Lykou G., Gritzalis D, 2016. Time-based critical infrastructure dependency analysis for large-scale and cross-sectoral failures, International Journal of Critical Infrastructure Protection, Volume 12, March 2016, Pages 46-60,

Strano E., Shai S., Dobson S., Barthelemy M.,2015. Multiplex networks in metropolitan areas: generic features and local effects, J. R. Soc. Interface 12, 2015

Su Z., Li L., Peng H., Kurths J., Xiao J., Yang Y., 2014. Robustness of interrelated traffic networks to cascading failures. Scientific Reports 2014;4:1–7. Article number: 5413

Sullivan JL, Novak DC, Aultman-Halla L, Scott DM., 2010. Identifying critical road segments and measuring system-wide robustness in transportation networks with isolating links: a link-based capacity-reduction approach. Transp Res Part A: Policy Pract 2010;44(5):323–36

TRB,2005. NCHRP Guide for Emergency Transportation Operations, Report 525, Surface Transportation Security, Volume 6.

Trucco, P., Petrenj, B., Bouchon, S., Di Mauro, C., 2015. "The rise of regional programmes on critical infrastructure resilience: identification and assessment of current good practices", Disaster Management and Human Health Risk IV, WIT Transactions on the Built Environment, 150, (2015), 233-245.

UNISDR & GFDRR, 2015. How to make cities more resilient. A handbook for local government leaders.

Vajda, A., H. Tuomenvirta, P. Jokinen, A. Luomaranta (FMI), L. Makkonen, M. Tikanmäki (VTT), P. Groenemeijer (ESSL), P. Saarikivi (Foreca), S. Michaelides, M. Papadakis, F.Tymvios, S. Athanasatos (CYMET), 2011. Probabilities of adverse weather affecting transport in Europe: climatology and scenarios up to the 2050s. Deliverable 2.1 of the RTD-project EWENT (Extreme weather impacts on European networks of transport) funded by the EC under FP7. Project coordinator: VTT, Espoo. Online: ewent.vtt.fi

Van Brabant, K.,2015. "Mainstreaming the Organisational Management of Safety and Security", HPG Report 9,March 2001

VOLPE,2013. Beyond Bouncing Back: Critical Transportation Infrastructure Resilience -

Vos, M., & Sullivan, H., 2014. Community Resilience in Crises : Technology and Social Media Enablers. Human Technology, 10 (2), 61-67.

Wang J, Jiang C, Qian J., 2014. Robustness of internet under targeted attack: a cascading failure perspective. J Netw Comput Appl 2014;40:97–104

Wasserman S. and Faust K., 1994.Social Network Analysis: Methods and Applications. Cambridge, U.K., ENG: Cambridge Univ., 1994

Welsh, M., 2014. "Resilience and responsibility: governing uncertainty in a complex world", The Geographical Journal, 180, (2014), 15-26.

White, K.J.S., Pezaros, D.P., Johnson, C.W.,2014. "Using Programmable Data Networks to Detect Critical Infrastructure Challenges", In: 9th International Conference on Critical Information Infrastructures Security (CRITIS'14), 13-15 Oct 2014, Limassol, Cyprus.

WHO, 2012. Integrated Risk Assessment. World Health Organazization <http://www.who.int/ipcs/publications/new_issues/ira/en/>

Wu J, Barahona M, Tan Y-J, Deng H-Z., 2011.Spectral measure of structural robustness in complex networks. IEEE Trans Syst Man Cybernetics Part A: Syst Hum2011;41(6):1244–52

Xu, T., Masys, A.J., 2016. "Critical Infrastructure Vulnerabilities: Embracing a Network Mindset", A.J. Masys (ed.) Exploring the Security Landscape: Non-Traditional Security Challenges, Advanced Sciences and Technologies for Security Applications (2016).

Yondong, Z., 2013. Social networks and reduction of risk in disasters: an example of Wenchuan earthquake. In: Yeung, W.J.J., Yap, M.T. (eds.) Economic Stress, Human Capital, and Families in Asia, vol. 4, pp. 171–182. Springer, Berlin (2013)

Zhao L., Lai Y.-C., Park K., Ye N., 2005. Onset of traffic congestion in complex networks, Phys. Rev. E 71, 026125 2005.

Zio E. and Sansavini G.,2011. "Component criticality in failure cascade processes of network systems," Risk Anal., vol. 31, no. 8, pp. 1196–1210, 2011

Websites

http://cyborginstitute.org/projects/administration/monitoring-tactics/

http://ec.europa.eu/clima/policies/adaptation/what/docs/non_paper_guidelines_project_managers_en.pdf

http://ec.europa.eu/dgs/home-affairs/what-we-do/policies/crisis-and-terrorism/tftp/index_en.htm

http://ec.europa.eu/eurostat/documents/64157/4392716/ESS-QAF-V1-2final.pdf/bbf5970c-1adf-46c8-afc3-58ce177a0646

http://ec.europa.eu/transport/themes/urban/studies/doc/2007_urban_transport_europe.pdf

http://ec.europa.eu/transport/themes/urban/studies/doc/2007_urban_transport_europe.pdf

http://ec.europa.eu/transport/themes/urban/urban_mobility/doc/apum_state_of_play.pdf

http://emergency.cdc.gov/planning/

http://floridadisaster.org/documents/CEMP/Emergency%20Operations%20Plan.pdf

http://hrdailyadvisor.blr.com/2012/06/07/emergency-management-preparedness-what-is-hr-s-role/#sthash.kngr3C7W.dpuf

http://managementhelp.org/strategicplanning/models.htm#one

http://rahat.up.nic.in/undp/TransportSOP.pdf

http://sydney.edu.au/whs/emergency/emergency2.shtml http://www.100resilientcities.org

http://www.ijbts-journal.com/images/main_1366796758/0026-Hossein.pdf

http://www.odpm.gov.tt/sites/default/files/NEMA%20Disaster%20SOPs%20and%20Contingency%20Plans%202000.pdf

http://www.organisationalresilience.gov.au/resources/Pages/default.aspx

http://www.resolute-eu.org

http://www.sadc.int/themes/infrastructure/transport/roads-road-transport/

http://www.scidev.net/global/communication/feature/early-warning-of-disasters-facts-and-figures-1.html

https://www.dhs.gov/sites/default/files/publications/niac-transportation-resilience-final-report-07-10-15-508.pdf

https://www.fas.org/sgp/crs/homesec/RL32520.pdf

https://www.gatwickairport.com/globalassets/publicationfiles/business_and_community/regulation/economic_regulation/14-10-01-operational-resilience-report-and-monitoring-report-final-for-publication.pdf

https://www.massport.com/media/266266/Report_A-Pre-Event-Recovery-Planning-Guide-for-Transportation-2013.pdf

https://www.oecd.org/daf/fin/insurance/OECD_APEC_DisasterRiskFinancing.pdf

https://www.volpe.dot.gov/events/beyond-bouncing-back-critical-transportation-infrastructure-resilience

ANNEX A: UTS ERMG SHORT VERSION

Develop Strategic Plan for UTS

Anticipate | Monitor | Respond | Learn

General Recommendations

- Attempting to gather board members and key employees together for planning
- Gather together all mobility stakeholders: mobility needs to be seen as a transversal domain of the Smart City
- Establishing the overall mobility goals for the alignment
- Establishing adaptive capacities goals to more effectively align operations to achieving the overall goal (measurable objectives through KPIs)
- Incorporating a "flexible" decision making process
- Securing the continuity to deliver cash generation through sustainable organization grow resources for including that information in the Strategic Plan.
- Producing a set of KPIs in order to monitor the evolution derived from the Strategic Planning
- Establish an effective business-government partnership with critical infrastructure owners and operators

Common Conditions Recommendations

Availability of resources	*Use of standards and involvement of all organization members*
Training and experience	*Domain knowledge*
Quality of communication	*Standardized communication instruments among internal and external shareholders*
HCI & Operational Support	*NA*
Availability of procedures and plans	*Integrated strategic plan*
Conditions of work	*NA*
Number of goals and conflict resolution	*Planning teams built accordingly to the goals*
Available time and time pressure	*Planning milestones and deadlines definition*
Team collaboration quality	*Follow the principles of collaborative planning*
Quality and support of the organization	*Funding and senior sponsorship in the planning process; involvement of all organizations*

Independencies Recommendations

If the related variability exceeds threshold of acceptance in relation to adaptation and improvement, the strategic planning should overcome such issues establishing and promoting an enabling management culture on self-protecting, so that appropriate adaptation action is undertaken.

Abstract

The function provides recommendation in relation to the management of strategic planning, that captures strategic goals/ objectives for supporting improve emergency preparedness and therefore increase resilience.

Background

In Urban Transportation Systems, critical infrastructures provide essential support to every socio-economic activity and the paths that convey people, goods and information, are the same through which risks are propagated. Hence, it is required a focused national strategy and supporting plans balancing resilience in UTS.

Example

The Transportation Strategic Plan (TSP) is the 20-year functional work plan for the Seattle Department of Transportation (SDOT) with actions SDOT will take to accomplish the goals and policies in the Comprehensive Plan over the next twenty years.

Limitations

Limitation due to generic strategic plan

Limitations due to quality of strategies

Limitations due to lack of integration across sectors

Manage Financial Affairs

Anticipate	Monitor	Respond	Learn

General Recommendations

- Assess potential disaster impacts and manage insurances & Governemental disasters risk financing tools, assess economic impact of transport disruption
- Plan financial needs, cost-sharing & control including all involved entities & ensure an efficient deployment of funds. Manage eventual over-payment situations, audit real use after crisis
- Plan financial needs to restore access to transport of critical goods & commercial business
- Analyse financial capacity & resources needs of each involved stakeholder including private companies, governments, public companies…)
- Plan budget reserve & how to unlock it in case of emergency needs. Revise it regularly,
- Manage staff with knowledge of financial resources

Common Conditions Recommendations

Availability of resources	*Persons in charge of financial affairs able to decide & budget available from all concerned entitities, finances control after crisis*
Training and experience	*Financial, project, crisis management, cooperation skills*
Quality of communication	*Communication to/with all involved stakeholders*
HCI & Operational Support	*Software tools to analyse financial data, plan & monitor budget and resources, communicate with all functions*
Availability of procedures and plans	*Strategic and operationnal plan ready before crisis*
Conditions of work	*Emergency & team work, ability to define priorities*
Number of goals and conflict resolution	*Manage conficting objectives during strategic plan phase, define priorities, have a general agreement, communicate to other parties*
Available time and time pressure	*Immediate response needed*
Team collaboration quality	*Collaborative financial planning though mutual benefit relations, define mutual financial responsabilities*
Quality and support of the organization	*Clear decision making process, align decision with available resources and defined priorities, measure performances, interprete financial results*

Independencies Recommendations

To manage the potential issues generated by the strategy planning function, an organization should consider applying the Corporate Social Responsibility (CSRR); this is a corporate self-regulation, to align the business model to goals that emphasise accountability for the impact of actions taken on stakeholders and the broader community in which business operate. CCSR encourages efforts to achieve a sustainable, positive impact through corporate activities. It provides opportunities to enhance the perception of a company's integrity and reputation, and can help increase brand recognition.

This function must provide the highest possible feedback to Coordinate Service delivery, Coordinate emergency actions, Monitor Resources availability, Use of services and Supply financial resources functions so that it can coordinate the financial management. This can be performed by direct communication or by continuously monitoring the operations.

Abstract

The function aims at financially sustaining operational, maintenance and emergency and recovery requirements. It assumes a critical role for all stages of system life cycle (design, operation and decommissioning).

Background

As financial resources assume a critical role for system operation, provision of resources and assets, financial affairs function is one of the prerequisites for any system current functioning and/or recovery as funds will be needed for managing full system recovery. This function is activated during normal operation as well as for emergency cases,

Example

Infrastructure Australia: Urban Transport Strategy from Federal government of Australia.

A Pre-Event Recovery Planning Guide for Transportation, TRRB report

Limitations

- Possible limited financial resources of involved parties
- Possible resistance of involved parties to plan a budget reserve in advance
- Possible incapacity of involved parties to produce a strategic plan

Perform Risk Assessment - Transport

Anticipate | **Monitor** | **Respond** | **Learn**

General Recommendations

- *The Integrated Assessment of different risk natures, i.e. safety, security environmental, 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; often 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 and risks, and the support of decision-making, for instance when reviewing safety cases. Due to highly dynamic operational conditions, the review of safety cases is likely to be frequent and under considerable time limitations.*
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 that respond to assessment needs of different process stages: planning, operation, maintenance, decommissioning, etc. Precision (quantitative and qualitative) of risk assessment must match process stage requirements and 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 while 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 a 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 fora 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.

Training staff

Anticipate | Monitor | Respond | Learn

General Recommendations

To develop and test the training material considering the aim of the training and the potential effects on the UTS's resilience. Staff should be trained to deal with events optimally, avoid general panic and timely eliminate risks and disasters. To contribute to the resilience of the system, training activities need to be organized in a manner that fulfils the following criteria, ensuring that the allocation of resources to training is coherent with the overall strategical planning, undesired variability in the training's outcomes is reduced, and training activities are revised to take newly discovered requirements into account.
To achieve, these training objectives for the UTS, it is important to integrate disaster risk reduction into formal education programs, to collect information and learn from past experiences, use UTS events as training case studies, examine similar training programs and their results on UTS resilience, develop risk reduction training for specific UTS infrastructure at the city level, work with local resources (Red Cross, universities, etc.) for a horizontal knowledge delivery approach and focus on training priority target groups.

Common Conditions Recommendations

Availability of resources	Human skills & competence: collection of training requirements; Budget working hours by trainers, trainees and HR specialists, training material, training location/infrastructure; Data & Algorithm: standardized documentation of requirements.
Training & experience	Feedback from trainer for improving the process. Prioritize training actions considering the role of involved parties and critical role of transport infrastructures/services.
Quality of communication	Efficient, understandable and accurate coordination and communication through standardized communication tools, protocols and languages. Make training objectives transparent to local authorities. Promote a "single window" information framework.
HCI & Operational Support	Depending on the kind of knowledge/skills mediated in the training, the choice of the right method is important, e.g., classroom training, simulator training, on-the-job-training, e-learning, game based training, safety and security trials, etc.
Availability of procedures & plans	Definition of training objectives and curricula should be formalized and embedded within the UTS organisation's HR procedures.
Conditions of work	Head of HR should ensure necessary conditions are created to perform the training, e.g. provision of space, materials, budget, buffer personnel. In case of trials in the public, training activities must not impede travellers' movements and should be made public.
Number of goals & conflict resolution	Legal requirements and directly relevant training objectives need to be prioritised in case time/budget make the accomplishment of all trainings impossible.
Available time & time pressure	Schedule trainings according to predicted demands, e.g., perform metro hub trials at times the metro does not operate.
Circadian rhythm & stress	Perform training during regular working hours, unless it requires a specific setting. Avoid an excess of working hours and workload for trainers and trainees.
Team collaboration quality	Provide trainings on: The principles of collaborative planning/management; Risk awareness and understanding of vulnerabilities and mitigation strategies.
Quality & support of the organization	UTS organisation should support training actions and prioritize training activities. Usage of different techniques to achieve a high quality training (e.g., role-playing, scenario-based training, training for role improvisation)

Interdependencies recommendations

- *Monitor Safety and Security is related with training security staff to properly interact in UTS events*
- *Perform risk assessment takes feedback from the training activities to assess risks in the UTS.*
- *Coordinate Service delivery creates training requirements.*
- *Coordinate emergency actions gives input to the development of training objectives and materials.*
- *Define procedures for training (locations, time, involve UTS stakeholders, etc.)*

Abstract

This guideline defines how to properly coordinate and evaluate training activities for UTS employees in order to ensure the resilience of a critical infrastructure.

Background

Training is a key element to ensure resilience. It compromises all activities performed to enhance knowledge, skills and abilities of UTS employees, with the aim of enabling them to better perform their specific job and to contribute to the resilience of the UTS.
Incentivize the staff to reduce risk behaviour and increase the effectiveness of their responses in emergency situations.

Example

Driver training in driving simulators and in vehicles without passengers for beginner drivers of trains.

Limitations

- *Training overall knowledge and under-standing of UTS operations is challenging.*
- *Guideline-based training approach targets only a finite number of known individuals.*

Coordinate Service Delivery

Anticipate | Monitor | Respond | Learn

General Recommendations

- *Adopting an holistic Service Delivery Framework aimed as a set of principles, standards, policies and constraints to be used to guide the deployment of services delivered to a specific user community in a specific business context*
- *Understanding infrastructure network criticalities as vulnerabilities, critical nodes/hubs, etc.*
- *Maintaining control on the entire supply chain (fuel, energy, spare parts, etc.)*
- *Establishing a permanent dialogue with the community served in order to adapt the service on the actual user needs in emergency and in daily operation*
- *Sharing transport information with authorities involved in the transport service as first responders.*

Common Conditions Recommendations

Availability of resources	*Provide adequate budget for the service delivery in the Strategic Transport Plan per transport provider. Transport service demand impacts budget allocation. Technical equipment, components of transport infrastructure, vehicles & transport applications of ICT infrastructure (VMS panels, Operation Control Centres, Traffic Management, integrated smart ticketing) to be used, with a resilient internet network covering all areas of service delivery.*
Training & experience	*Staff adequately trained to implement relevant rules and procedures (operating, communications procedures, safety & security procedures) and periodically tested for knowledge of routine and emergency rules and procedures to catch up updated operating procedures. Staff should also be trained for transport applications of ICT infrastructure.*
Quality of communication	*Clearly define all potential communication channels among stakeholders(VMS, information signs, maps), provide emergency communication plan. Use standardized communication tools, protocols and languages.*
HCI & Operational Support	*Provide operational support for use of ITS, training procedures and suitable software to assist responsible personnel.*
Availability of procedures & plans	*Responsibility matrix, operating, safety & emergency rules and procedures as well as trained staff. Preventive and failure-driven maintenance of transport infrastructure.*
Conditions of work	*Ensure best possible conditions of work, considering air quality and lighting conditions for metro service staff and drivers work in urban road traffic conditions.*
Number of goals & conflict resolution	*Incrementing service delivery performance to address unexpected increment of demand should consider safety & security requirements. In case of conflict with other organizations, prompt communication to stakeholders affected by the decision required for a synchronised systemic response to an unexpected event.*
Available time & time pressure	*Flexibility when planning milestones and deadlines to cope with quality requirements (itineraries, time of first and last buses close to metro stations close to time of first and last trains to achieve transfers in marginal times.).*
Circadian rhythm & stress	*Ensure compatible nightshifts for staff of various service operators while not reducing the expertise. Train driver recruitment procedures should include psychometric tests.*
Team collaboration quality	*Team performance at each transport unit level is an essential KPI over and above individual performance metrics.*
Quality & support of the organization	*Perform regular audits to check the need to update operating procedures following specified time periods. Perform audits to check the need to update operating procedures following disruptions of transport service.*

Interdependencies Recommendations

Apply emergency exercises and emergency communication plans to coordinate transport emergencies effectively. Efficient coordination of service delivery should also take into account user behaviour and awareness of service characteristics. User generated feedback should be monitored to adjust the coordination of service delivery to changes of service peaks.

Abstract

The function aims at coordinating service delivery during ordinary /normal operation, as well as during and after incidents/disruptions of normal service.

Background

Coordination of transport service delivery before a disruption, concerns business as usual where standard operation and safety procedures should be used. Coordination of transport service delivery during or after an incident/event requires the implementation of emergency rules and procedures as well as wider communication and coordination with first responders.

Example

USA Department of Transportation (DOT) and its partner agencies, have juggled the roles of funder, owner, operator, guider, and regulator of the Nation's transportation infrastructure to coordinate UTS service delivery and build resilience in the transportation system.

Limitations

Legal framework and/or internal policy of organizations may impose limitations in particular on the adoption of data sharing approach or the creation and maintenance of a dialogue with users

Manage awareness & user behaviour

Anticipate	Monitor	Respond	Learn

General Recommendations

- Develop engaged communities with active participation of members to foster awareness and responsible behaviour, along with the teaching of common knowledge.
- All communication to the users or the public should be based on a communication plan.
- Collaboration and support with governmental, private or public organisations should be sought to implement long-term actions, such as campaigns or educational programs.
- Public awareness campaigns are recommended in the case of new adverse events or if safety advice from the organisation has not been followed by the public.
- Design the communication strategy around the addressability concept (4R).
- At individual user request, provide 1:1 “how to”- advice.
- Establish a people-centred early warning system.
- Communication systems should be tailored to meet the needs of every user group.
- Consider the use of social marketing and an evidence-based approach.

Common Conditions Recommendations

Availability of resources	*Human skills & competence: experts in different fields (public relations or marketing, UTS service delivery, etc.) with special training for emergency situations; Budget adequate for proper signalling, educational campaigns, training, promotions, etc; Technical equipment: state of the art equipment, components of transport infrastructure, technologies for alerts. Data & Algorithm: collect and exploit statistical data to tune and improve communication.*
Training & experience	*Assess the level of awareness and communication of travellers and UTS employees; Train UTS's staff for safety and security issues in resilience management.*
Quality of communication	*Use of predefined messages or message types to ensure content quality. Test communication channels and tools before use. General principles: accessibility, inclusiveness, inter-operability.*
HCI & Operational Support	*Applications undergo usability testing. Development of smart apps to raise awareness, inform about alerts and communicate facts.*
Availability of procedures & plans	*Develop procedures to guide communication activities, data collection etc. Ad-hoc messages (e.g., alerts): procedures including general standards (specific messages, use of channel, precise phrasing) need to be defined.*
Conditions of work	*Responsible staff needs to be continuously provided with status information or orders from the coordinators of UTS service delivery.*
Number of goals & conflict resolution	*Conflict resolution procedures need to be established in case of incompatible orders. Individual communication on evacuation procedures should provide specific information for vulnerable groups and users with special needs.*
Available time & time pressure	*Ensure a degree of flexibility when planning milestones and deadlines. Prioritize actions (safety first, children and reduced mobility persons first). Communications related to safety issues should be prioritized.*
Circadian rhythm & stress	*NA*
Team collaboration quality	*For managing awareness and user behaviour it is important to have a high quality collaboration between all relevant stakeholders.*
Quality & support of the organization	*UTS authorities and key decision makers should achieve a high quality of communication and support common targeted decisions for UTS resilience.*

Interdependencies recommendations

Monitor user generated feedback, assessing the level of awareness and behavioural changes towards resilient movements. Collect event information, providing input from travellers and tracking behaviours. Coordinate service delivery, monitor operations, manage ICT resources. Monitor safety, security and resource availability. Coordinate emergency actions.

Abstract

This guideline defines how to increase the resilience of a critical infrastructure by taking directed influence on the perceptions and behaviours of non-staff users of the UTS. Such users are in many cases the general public or customers of the service provided.

Background

This guideline is directed at UTS infrastructures that are used by passengers or other persons who are not related to the infrastructure through an employment status in any involved UTS organization. Since safety and emergency awareness of the general public are of great importance, it is recommended to promote safety-relevant behaviours through public multi-media communication.

Example

ATTIKO Metro Athens:

- *Partnering between a local metro company and the local government to promote alternative routes for cases of flooding.*
- *Planning of evacuation routes from a metro station for different user groups, including vulnerable users such as wheelchair users or persons with diminished eyesight.*

Limitations

The effects of UTS awareness campaigns are never guaranteed. The UTS staff responsible should always be prepared for undesired user behaviour.

General Recommendations

- Identify the goals and objectives for the emergency response procedures (e.g. evacuation of disaster area through public transport and government vehicles, limit the access to the disaster area, cleaning and reparation of access routes).
- Review hazard or threat scenarios from the risk assessment.
- Assess the availability and capabilities of resources for all involved organizations.
- Determine if there are any regulations(e.g. LTZ accesses, one-way routes) pertaining to emergency procedures at the addressed facility; address the management of existing regulations in the plan.
- Define actions for life safety (evacuation, closure of access to the disaster area, communication through all available means: VMS, web portal, mobile APPs, ecc. & control through all available means: UTC, LTZ, etc.).
- Develop hazard and threat-specific emergency procedures.
- Coordinate emergency planning with public emergency services.
- Train personnel so they can fulfil their roles and responsibilities.
- Express procedures in a clear and concise way.
- Facilitate exercises to practice the operational procedures defined in the emergency response plan in a real life environment

Common Conditions Recommendations

Availability of resources	*Budget planned for procedures definition; specialized personnel*
Training and experience	*Operational procedures need to be subject of training, exercise and feedback*
Quality of communication	*Communication tools need to be foreseen for internal and external communication towards the users*
HCI & Operational Support	*NA*
Availability of procedures and plans	*Both availability of communication channels and precise phrasing in the procedures*
Conditions of work	*NA*
Number of goals and conflict resolution	*Procedures need to be concise and clear*
Available time and time pressure	*Procedures need to be validated in real-life environments*
Team collaboration quality	*Procedures should enable efficient team collaboration*
Quality and support of the organization	*Funding should exist for definition, training and testing for operational procedures*

Independencies Recommendations

The risk assessment should provide the basis for procedures development and should follow a standard (e.g. OSHAS); nevertheless in case of missing or incomplete risk-assessment the process of developing procedures should overcome to this in Step 2. Operational Plans describe the "what" and SOP describe the "how." The SOP should grow naturally out of the responsibilities identified and described in the Operational plans. All defined procedures should follow standard guidelines in relation to existing safety and health regulations (e.g., OSHAS 18001).

Abstract

This function is dealing with the management of the operating procedures, as a set of instructions of carrying out tasks without loss of effectiveness in case of emergency, according to risk assessment and ex-post event analysis (learning) in a re-usable and re-plicable way.

Background

The purpose of Standard Operating Procedures (SOP) in Urban Transportation Systems (UTS) is to ensure smooth transportation links at both city and regional level generally and especially within emergency context; in particular it should guarantee the level of service and safety at hotspots across the transportation network.

Example

PEN INDIA TECHNOCRATS has developed the SOP for ESF 'TRANSPORTATION' with aim & objective to have least Response Time in case of emergencies involving from a transportation point of view.

Limitations

Limitations related to complexity and non-applicability.
Limitations related to knowledge for correct application.

Manage Human Resources

Anticipate | Monitor | Respond | Learn

General Recommendations

- Human resource availability needs to be secured for both daily activities and during emergency. A dedicated buffer capacity should be defined in advance and tailored according to emergency scenarios ;
- Implement a Human Resource Management system/Human Capital Management System in the organization
- HR should manage employee stress and burnout caused internal and/or external factors
- Implement a Human Resource Replacement Plan to replace missing human resources with other with the same experience
- Implement a Knowledge Transfer Strategy to anticipate and manage retirement, dismissal or leave of absence of specialised staff
- Experienced recruiters should take responsibility for preparing managers and members of the recruitment panel for interviews with candidates

Common Conditions Recommendations

Availability of resources	*Humans skills:* *compensation & benefit recruitment and hiring, performance evaluation, training and staff development, adaptation & flexibility; Data & Algorithm: Use HRMS/HCM system to manage information on knowledge, skills & abilities, interests, General Work Activities and work context data; Financial plan: Recruitment activities to follow the financial plan. Gather labour market intelligence coherently & consistently to quantify skill requirements' market value*
Training & experience	*HR managers prepared to respond to rapidly changing workforce dynamics, and equipped with sound knowledge and a wide repertoire of skills to address the four top competency areas in human resources environments across all industries.*
Quality of communication	*Open and transparent organisational culture, continuous organisation dialogue between managers & employees, through structured feedback meetings, focussing on individual performance and professional growth.*
HCI & Operational Support	*Integrate HRM System with IT physical Security Access control system to ensure real-time employees' access management.*
Availability of procedures & plans	*Adopt skill & competences categorization and experience levels; Minimize downside to employee for participation; Include policy to scale employee access during emergency; Use research findings to manage hostile insider.*
Conditions of work	*HR management, having in mind health and safety concerns regarding every employee, has the responsibility of defining working conditions in terms of tasks, workstations, work schedules, shift work, workloads and every individual or collective protection against heavy work and/or risky conditions.*
Number of goals & conflict resolution	*Motivational approach through inducements and contribution strategy. Ensuring equal opportunities of careers. Attention to achieve a sustainable work/life balance.*
Available time & time pressure	*Working conditions should be designed to minimize the impact of variability and time pressure while continuously enhancing inherent human adaptive capacities.*
Circadian rhythm & stress	*HR management should perform leadership encouraging employees and favouring their risk perception, decision-making and performance.*
Team collaboration quality	*Build a cross-departmental insider threat approach and response team, to include: IT, Physical Security, Legal, and Human Resources.*
Quality & support of the organization	*Establish a strong Employee Assistance Program to help employees identify themselves and peers for assistance during high-risk periods of difficulty.*

Interdependencies Recommendations

Emergency HR request: Establish formal connection with emergency responders to create a reliable communication channel. Managing pay & benefit for employees engaged in emergency response. Operation HR plan: ICT is a fundamental resource for all activities across multiple stakeholders.

Abstract

Human resources management is devoted to hire experienced human resources, develop human capital and to manage human reliability in task execution. To this end, skilled HR manager should be employed, and a person centric approach considering not only the skill at work but also parameters as family conditions, attitude, belief, etc. should be applied. Such a complex way to manage human resource require advanced software application.

Background

HR serves the purpose of supporting:

- *The alignment of organizational human capital with missions and programmatic goals.*
- *The adoption of long-term strategies for acquiring, developing and retaining competences and expertise.*
- *Previewing the continuous update of all actors' competencies, skills and risk awareness, according to technological changes in the Transport sector.*

Example

Quito city in Ecuador established a municipal risk management system by carrying out policies in an integrated manner to security, addressing situational risks, road safety and risks to natural and technological hazards. More information at: http://www.quito.gov.ec

Manage ICT resources

Anticipate	Monitor	Respond	Learn

General Recommendations

There should be delivered and maintained a well-established plan dealing with all the possible difficulties that takes into account all ICT resources needs in UTS. Additionally, effective ways that maintain information and communication systems among transport system managers, staff and users under normal and extreme conditions should be developed. The needs of the urban transportation should be addressed through innovative applications of broadband, mobility and cloud services, such as: smart vehicles and infrastructure, transportation services, multimodal transportation and redefined city spaces. Moreover, the ICT should be utilized for transport management practices, as well as for emergent situations (e.g. when evacuation of an area is needed). Finally, Traffic lights, traffic control sensors and video-surveillance, vehicle management systems and communication channels need to be in deep integration to allow both resilience and risk management.

Common Conditions Recommendations

Availability of resources	*A variety of traffic monitoring and surveillance systems; Travel time and speed data should be available; Design critical components of the transportation system to be fail-safe, self-correcting, repairable, redundant and autonomous; Distribute emergency evacuation information to at-risk populations.*
Training and experience	*Staff cross-training to perform critical management and repair services. Training of people to be able to manage, update, and repair in time the ICT resources. Regular test exercises for the technical experts. Educating and creating awareness in the population.*
Quality of communicat ion	*Ensure quality communication through ICT with citizens. Consider the use of VANETs (Vehicular Ad hoc Networks). Ensure information sharing. Revise regularly technical standards for important communications.*
HCI & operational support	*The system should be able to identify and contact vulnerable people, provide individualized directions for their care and evacuation, and establish a chain of responsibility for caregivers. User-friendly platform for the technical experts and the citizens. Ensure the communication of citizens and rescuers in emergencies.*
Availability of procedures and plans	*Institutional arrangements should be made to enable transportation operators to sustainably manage their infrastructure assets. Maintain contingency plans to allocate fuel and other resources in emergencies. Revise technical standards on measures for countering congestion. Transport Planning for Disaster Management.*
Conditions of work	*Friendly working environment. ICT infrastructure should be accessible for all.*
Number of goals and conflict resolution	*The roles and responsibilities of each team member should be clearly define d and not overlapped in order to avoid conflicts. The number and scale of tasks/responsibilities assigned to each person should be reasonable based on the ICT management plan and the corresponding timetable. Specific rules/principles should be defined in conjunction with a hierarchical working structure in order to address possible conflicts.*

Independencies Recommendations

In order to monitor the operation of the UTS, the necessary ICT equipment and services have to be set/installed. In addition, the definition of the procedures has to be performed considering the requirements of the ICT infrastructure. In case of a detected problem, immediate action should be taken based on the backup plan in order to reduce any negative consequences. Finally, user generated feedback should be considered in a timely manner in order to ensure proper and efficient ICT operation.

Abstract

This guideline provides advice towards managing ICT resources in order to support critical infrastructure operation and management. The management of the ICT resources for a critical infrastructure includes the provision, maintenance, update and development of information and communication equipment and services.

Background

Urban transportation systems have been some of the most active areas of ICT deployment, which has proven to play a crucial role for the efficient management and optimization of urban transport operation especially in case of emergency or disaster.

Example

CRAMSS aims to support reference actors at the UTS, such as infrastructure managers, with their decision-making under both typical and atypical conditions. Displays information from different sources or independently running web-applications, together with the results of the decision support

Limitations

ICT cannot eliminate possible economic loss and damage to property in case of a disastrous event. There is lack of adequate financial support

Maintain UTS physical/cyber infrastructure

Anticipate	Monitor	Respond	Learn

General Recommendations

Physical infrastructures of UTS can be divided into these main areas: Sensors/hardware positioned on the ground: surveillance and traffic monitoring video cameras, sensors, telematics gates controlling entrance/exits to/from specific areas/roads; On-board hardware: personal devices of workers used as moving sensors, on-board control units, hardware necessary to make the vehicle work and connect to the transport control centre; Hardware of the Transport Control Centre; Transport vehicles ; Enabling ground infrastructures (e.g. tram line pathway).

Maintenance activities need to be organized to satisfy the following criteria:

- Verify the presence of requirements relevant to maintenance in contract/procurement documents.
- The allocation of resources to maintenance is coherent with the size of the infrastructure and maintenance policy.
- Maintenance activities are revised periodically to take into account new discovered events and requirements.
- To be more responsive to unforeseen issues, adopt from the beginning (resilient by design) prognostic models in order to perform "predictive maintenance".

Common Conditions Recommendations

Availability of resources	*– Human skills & competence: continuous exchange of information between personnel* *– Budget: adequate financial resources are needed for regular maintenance* *– Data & Algorithm: data exchange processes shall be used to control UTS*
Training & experience	*– Efficient maintenance training help to rationalize asset usage* *– Mobile technologies can increase the effectives of maintenance operations*
Quality of communication	*Efficient, understandable and accurate coordination and communication through standardized communication tools, protocols and languages.*
HCI & Operational Support	*– Usage of maintenance SW tools for focused intervention plans* *– Usage of SW tools implementing procedures to take right decisions*
Availability of procedures & plans	*Develop a strategy for maintenance of UTS infrastructure and share it among all maintainers and stakeholders*
Conditions of work	*– If possible it is preferable to allow maintenance employee to work on UTS assets within company headquarter* *– Proper attention shall be paid to security working conditions for on field work*
Number of goals & conflict resolution	*– Early detect anomalies in order to reduce crisis times and efforts* *– Increase the amount of data collected during the crisis*
Available time & time pressure	*– Maintenance activities shall be done during normal infrastructure operation* *– Workers shall perform rapidly to be fast in solving crisis*
Circadian rhythm & stress	*– Allow workers the proper time shifts.* *– Avoid an excess of working hours.*
Team collaboration quality	*– Improve quality of human relation specially between technical personnel* *– Proper collaboration and communication strategies shall be implemented among different stakeholders*
Quality & support of the organization	*– Maintenance process shall be based on clear decisions* *– Maintenance organizations shall have clear assignment and work-flow*

Interdependencies Recommendations

The current guidelines are linked to many other critical functions related to the UTS resilience:. Strategic planning and financial budget planning is an important input to the Maintenance of Cyber and Physical UTS infrastructures. Such a function is related and propedeutic to the service delivery, and to the monitoring of operations and ICT subsystems. Human resources management and training is a critical success factor for an effective maintenance of UTS subsystems.

Abstract

This guideline reminds best practices and references to coordinate the maintenance service and allow the UTS subsystems, assets, HW equipments and ICT infrastructures to operate efficiently and safely .

Background

UTS infrastructures are critical for any city. Such infrastructures need to be maintained to guarantee a safe service during regular operations and to be able to adapt in case of emergency.

Ordinary maintenance is related to the need to monitor the systems during regular operation.

Extraordinary maintenance is related to the capability to adapt the assets to ensure "best-effort" operations for the safeguard of population during emergencies.

Example

- *Kuala Lumpur: substantial investments were spent from both the Federal Government and City Hall to develop Kuala Lumpur's Stormwater Management and Road Tunnel, to maintain flood retention ponds and main drains, to maintain rivers and main drains, and to cleanse rivers.*

Limitations

- *Too complexity in cyber infrastructure leads to parts not properly maintained.*
- *Many current technologies lack standards for maintenance.*
- *Lack of human resources forces the same person to maintain multiple systems increasing probability to make errors.*

Monitor UTS Safety & Security

Anticipate	Monitor	Respond	Learn

General Recommendations

In order to perform effective monitoring of safety and security, the Urban Transport System must establish transport infrastructure and processes that support and enable the monitoring needs (e.g. CCTV cameras at stations and stops, office with security staff to report and react when needed). This implies that this system collects, organizes, records and makes available the necessary information in a manner that is timely, accurate and that ensures data confidentiality, integrity, and availability. Moreover, these data must be reliable and be communicated directly to response bodies (security staff, police, traffic police, etc.).

Common Conditions Recommendations

Availability of resources	*Personnel: security staff, staff monitoring real time safety & security conditions; Equipment: CCTV cameras on the network, equipment for the monitoring centre, including alert systems; Budget: buy, replace and/or maintain security equipment, maintain road safety infrastructure, safety & security personnel salaries; Processes: safety instructions and priorities, pinning "blind spots", mapping mobility related accidents and violence disturbing movements; Material:, data collected, stored and their format – videos/log files/ reports.*
Training & experience	*Required training involves: operating, monitoring, and configuring monitoring systems components; timely response to alerts and communicate events to security response bodies; supporting stakeholders in understanding and interpreting monitoring data; securing data collection and analysis from monitoring system components;*
Quality of communication	*Basic principles: accuracy, validity, security and timeliness of data; Monitoring data protection from unauthorized, inappropriate access during collection, storage and transmission to users and stakeholders; Personal data and cyber security treatment, according to existing standards and regulations; Means of communication to avoid panic and retain the sentiment of personal safety & security in a tolerance level.*
HCI & Operational Support	*Personnel responsible for handling monitoring equipment, need to be properly skilled (through adequate training and previous experience) to handle safety & security data, analyse and combine them, to understand and communicate information and alerts.*
Availability of procedures & plans	*Clearly defined in the Safety & Security Urban Transport Monitoring plan and comply with the monitoring requirements as defined by the needs of the addressed stakeholders; Responsibilities and recommended actions in normal routine or in case of an emergency.*
Conditions of work	*Clearly specified responsibilities for all involved parties/staff in order to activate the alert system and operate efficiently in case of emergency*
Number of goals & conflict resolution	*Personnel authentication; tickets validated at each transit stop; CCTV videos monitoring data; complaints office data from hub travellers; input from road reports, traffic police data, statistics; real time communication with response bodies (police, traffic police, station security)*
Available time & time pressure	*Automation in task execution (part of working routine); Timely and effective data collection, considering time for sense making of data*
Circadian rhythm & stress	*Management of employee fatigue to avoid safety critical errors; Unbtrusiveness and automation in safety and security monitoring procedures.*
Team collaboration quality	*Specification of involved stakeholders, their roles and responsibilities in the process plan, for collecting, recording, distributing, and ensuring the confidentiality, integrity and availability of monitoring data; Inclusion of process tasks and responsibility in specific job description*
Quality & support of the organization	*Establish and Maintain a UTS Monitoring Program; Perform Monitoring.*

Interdependencies Recommendations

Risk Assessment report would define the procedures of special focus for UTS safety & security monitoring, as the ones of higher risk and thus needing closer attention and preventive measures. *Emergency actions coordination* should be consulted in defining the emergency response plan and timing along with safety & security critical event detection. *Operations monitoring* should be in close cooperation with safety and security monitoring, as the overall monitoring actions for safety and security control within the transport system. The *collection of event information* is closely related with safety & security monitoring as these event information data are used to assess and monitor safety & security in the UTS.

Abstract

Safety & security issues of transport operations and service delivery include maintenance problems, accidents, (non) recurrent traffic congestion, extreme weather conditions, as well as unexpected events. Traffic Management and Operation Control Centers adequately staffed and equipped, interactions and communication channels with Police, Traffic Police and Data Protection Authorities are important to perform the function.

Background

Safety in UTS refers to manners and actions that ensure safe movements and eliminate traffic or other mobility related accidents, while security deals with the feeling of safety people have while moving (terrorism attacks, extreme weather conditions, etc.). Therefore, monitoring safety & security in the UTS is a necessity in terms of resilience management and sustainable movements.

Example

The benefits of transportation video surveillance are: Prevent crime and deter criminals; Prevents vandalism; Safer environment for passengers; Holds employees accountable for their responsibilities; Remote viewing off-site from a smartphone or tablet; Reduces liability in cases of passenger injuries

Limitations

Lack of resources may lead to assigning safety & security monitoring to an external entity. Additional provisions for data security should be made and a MoU between the UTS manager and the external operator should be defined, regulating data collection, management and exploitation.

Monitor Operations

Anticipate	Monitor	Respond	Learn

General Recommendations

Monitoring must take into account the growing need to follow up on any overall operational context changes and events, as it may present fundamental opportunities for preventive and proactive operational adaptations to such changes.

- *Consider Active (data generated by inter and massive monitoring method.*
- *The use of multi-disciplinary teams to analyse such operational changes tends to provide useful operational sense-making*
- *Increased need for integrated risk assessment in order to ease coordinated risk management actions and measures.*
- *Monitoring operational performance can be executed with different timeframe according to the Resilience Management Level*

Common Conditions Recommendations

Availability of resources	*Human Skills & competence secured by Human Resource Replaced Plan; ICT infrastructure to be reliable, scalable, not create impact on the system to be monitored, failure in monitored system should not cause a failure in monitoring system, run as distinctly as possible from the production Environment. Adopting a Unified Open System Approach; Define a data quality profile for each data source and a method for quality assessment addressing: Relevance, completeness, consistency, accuracy, timeliness, integrity, accessibility and clarity, comparability and coherence.*
Training & experience	*Increase risk perception capacity. Training employees in view of system thinking, creative problem solving and naturalistic decision making.*
Quality of communication	*Secure data and communication understandability and early warning.*
HCI & Operational Support	*Equipment and control rooms should be designed in accordance with ergonomics standards of reference. Staff should be involved in the design process. Interfaces should be usable in both normal and emergency situation.*
Availability of procedures & plans	*Define clear procedures that recognize distributed decision making requirements.*
Conditions of work	*Establish a Safety Culture in the organization, beyond the classical approach, towards safety and adaptation as an internal organization value.*
Number of goals & conflict resolution	*Adapt a mind-set of openness, trust and fairness. Careful trade-off between safety and efficiency demand. Consider the level of independence of employees to be fair and impartial.*
Available time & time pressure	*Understand demand over time for being prepared (if predictable) to changing conditions. Separate Value and Failure demand. Look at how the system respond in terms of adjustment and adaptation to demand dynamics.*
Circadian rhythm & stress	*Managing fatigue and workload as hazard in terms of reduction of mental and physical performance. This affects the capacity of perceiving external stimuli that might come from the monitoring system. Some tasks may be re-allocated from humans to machines/computers, or vice-versa; considering human performance, safety, maintainability, personnel requirements.*
Team collaboration quality	*Consider the information flow: Field experts of all kinds, (including system actors, designers, influencers and decision makers) need effective ways to raise issues of concern, including problems and opportunities for improvement and need feedback on these issues.*
Quality & support of the organization	*Implement an active monitoring consisting of checking activities, formal and informal, carried out by line managers which lie at the heart of effective management. The topics which are actively monitored must include those barriers or controls needed to prevent a major accident.*

Interdependencies Recommendations

Monitoring function is strictly connected with the emergency coordination function. Moving from the single-ended monitoring of the past to the integration of multi-monitoring and central control systems, evolving from "monitoring without control" into smart, integrated system.

Abstract

Monitoring refers to the practice of collecting data regarding the infrastructure and operation in order to provide alerts both of unplanned downtime, network intrusion, and resource saturation.. Monitoring provides the basis for the objective analysis of systems performance in view of the potential need for adaptive behaviours.

Background

In Urban Transportation Systems (UTS), monitoring operations contribute towards a better execution in decision making and mobility actions in the controlled urban area. Responsibility for monitoring, i.e. the collection of the figures, calculation of desired Key Performance Indicators (KPIs) and for comparison of output with target, lies at different levels of supervision. .

Example

The Makati Command, Control and Communication (Makati C3) centre was developed to serve as the city's Emergency Operations Centre dealing with monitoring, coordination, and integration of services and resources during disasters and emergencies with an active role in risk-sensitive land use planning and community-based disaster risk reduction. Read more at http://tinyurl.com/7su6wtw.

Limitations

Improving an effectiveness monitoring and early warning UTS does not lead to reduced risk for disaster-prone communities.

Monitor Resource availability - Transport

Anticipate	Monitor	Respond	Learn

General Recommendations

Understanding the interdependencies that ensure system functioning and operation is fundamental for the safe, effective and efficient allocation and deployment of resources and should seek:

- *The way in which interdependencies support the provision of critical resources;*
- *The types and degrees of variability to which these are submitted in the face of pressures emanating from a system's operational environment.*

In many transport networks, despite considerable developments in communications and in operations monitoring capabilities, the use of local staff and on sight operational agents has shown important safety and efficiency benefits: Improved efficiency in passenger flows ; Improved safety, security and operations monitoring; Improved response to events and operational changes.

Common Conditions Recommendations

Availability of resources	*Technical and organisational conditions ensuring acceptable workload, managing fatigue and stress in order to anticipate negative effects on job performance, controlling workability across ageing, and promoting health, arousal and preparedness towards prompt reactions in emergency situations. Ensure the required budget for the system functioning and emergency situations. Preview the needs for external operations and the related budget.*
Training & experience	*Continuous & updated training to maintain & improve relevant skills & expertise for allocation and deployment of all available resources.*
Quality of communication	*Information constitutes one of the most critical resources. Efficient and safe use is reliant on the accuracy and quality of communications.*
HCI & Operational Support	*Control room systems design and appropriate support to decision-making processes is thus placed at the core of transport safety and efficiency at large*
Availability of procedures & plans	*Forums of operations related staff that review available data to forecast operational conditions for upcoming days or weeks and adjust level of operation capacity of the network (or for the parts of it potentially affected) to forecasted conditions of operation (i.e. weather conditions, social events…).*
Conditions of work	*Condition of work must be aligned with resource availability, so as to ensure an efficient and effective deployment of available resources.*
Number of goals & conflict resolution	*Monitoring the adequate allocation and deployment of resources is critical for the management of trade-offs between operational goals and needs in such a way that safety requirements are not compromised.*
Available time & time pressure	*Time is the utmost critical resource without which the efficient and safe use of other resources can be compromised. Strongly relies on adequate planning.*
Circadian rhythm & stress	*Shift work or roster conditions may impose the need for flexible management and deployment of resources. Monitoring resource availability may become complex due to increased diversity and variability of factors to be taken into account.*
Team collaboration quality	*Monitoring changes in resource availability and re-assessing resource requirements as operational conditions change, requires close cooperation within and across work teams.*
Quality & support of the organization	*In transport systems, organisational resources are particularly critical for the coordination between multiple and diverse local needs and conditions.*

Interdependencies Recommendations

- *Monitoring resources generates information on their allocation & the understanding of their flows.*
- *ICT constitutes a fundamental resource for all activities across multiple stakeholders.*
- *A dedicated communication & periodic reporting channel should be established throughout the supply chain.*
- *A specific protocol & procedures to promptly inform about resource delivery failure & the related causes should be defined in advance between supply chain stakeholders.*

Abstract

As every resource should be available for the system functioning & prompt for any emergency request, the related guidelines should comply w/ the control of:

- *Expertise & functional human abilities in relation to the system functioning;*
- *Technology required for the system functioning;*
- *Organisational conditions favouring the system functioning & the mobilisation of resources in emergency situations.*

Background

The high complexity & dynamics emerging from system interdependencies require a continuous ability to monitor the flow of multiple critical resources, aiming to develop updated & thorough support to the planning of operations & the subsequent resources allocation.

Example

Best practices in risk and crisis communication: Implications for natural hazards management (Toddi A. Steelman • Sarah McCaffrey (2013).)

Limitations

- *Updating information on resources use.*
- *Assessing the situation and mobilising the appropriate resources.*
- *Unavailability of technological assets resulting from breakdown or lack of energy.*
- *Variability of human resources and of their performance.*

Monitor user generated feedback

Anticipate	Monitor	Respond	Learn

General Recommendations

- Leveraging a bottom-up engagement of travelers through social media monitoring (“social/human sensors”, “travelers as moving sensors”, etc.)
- Analysis of user generated contents through Text Mining and Natural Language Processing (NLP)
- Deploying ICT systems for managing structured real-time information related to road traffic density, level of service, speed or public transport ridership
- Adopting cloud-based platforms for Big Data management & analysis.

Common Conditions Recommendations

Availability of resources	*Costs for accessing, implementing and updating of social/human sensing data must be considered*
Training and experience	*Social media monitoring, communication skills, statistics and data mining*
Quality of communication	*Diffusion through different channels, in particular social networks and media, to reach any user reducing possible “digital divide”*
Human Computer Interaction and operational support	*Access to social/human sensing data and data analysis software for supporting the UTS operators during the emergency management.*
Availability of procedures and plans	*Procedures related to the communication to the public; frequent update to consider the preferred channels over time*
Conditions of work	*Privacy and security of data crawled from web and socials*
Number of goals and conflict resolution	*Reducing time to recover the normal condition*
Available time and time pressure	*Accessing, browsing and examining data in very short time through easy friendly visualization*
Team collaboration quality	*Adherence to the principles of collaborative planning through the development of mutual benefit relations*
Quality and support of the organization	*Alignment of responsibility for communication actions*

Independencies Recommendations

- Correlating user generated data (social/human sensing) with official data coming from ICT based monitoring and control systems
- Communication mechanisms and channels used to monitor the UTS service
- Communication mechanisms and channels can be refined and improved to infer, characterize and possibly predict UTS usage behavior as well as increase travelers awareness

Abstract

This function provides recommendation for implementing a human/social sensing approach to support a more effective and efficient resilience management of UTS

Background

Smartphones and social networks (e.g. Twitter, Facebook, Instagram, etc.) has enabled an every-time and every-where collaborative and active participation of citizens who are free to generate and share information and opinions on the UTS

Example

The Federal Emergency Management Agency (FEMA) wrote in its 2013 National Preparedness report that during and immediately following Hurricane Sandy, “users sent more than 20 million Sandy-related Twitter posts, or “tweets,” despite the loss of cell phone service during the peak of the storm.”

Limitations

Trustworthiness of the sources: data generated by citizens contrary to official data sources (such as ICT based monitoring and control systems) cannot be completely considered “trustworthy”

Coordinate Emergency Actions in UTS

Anticipate	Monitor	Respond	Learn

General Recommendations

Coordination of UTS emergency actions includes: assuring leadership on system operation until emergency is closed; redefinition of service needed in the given emergency magnitude; on-the-field coordination activities to manage road signs to advertise traffic changes; re-routing & timetables rearrangement of UTS when and if possible; cooperation with other first responders/law enforcement such as local police and civil protection; complementarity of mobility modes in case of enduring service level loss, in accordance with service level agreement; communication of the current mobility conditions to citizens and stakeholders; caring the diffusion of clear contents, in proper channel.

Common Conditions Recommendations

Availability of resources	*Human skill and competence; Leadership; Financial reserves; Information stored in databases and access to GIS; Information access through dedicated dashboards; In addition to scientific, technical, legal and procedural education, simulations and case studies, as a preparation to cope with UTS re-adaptation during emergencies, must be available.*
Training and experience	*Regular exercises with active participation of cross-organizational UTS personnel; Regular meetings among teams and responsible figures involved; Simulation tools; Programs towards the public to generate awareness; Emergency actors must know each other in person, having clear, fair communication, and having established a relevant human empathy among them in the ordinary time, well before the emergency begins.*
Quality of communication	*Operational procedures need to clearly specify who is in charge of communication; Real time communication on multiple, alternative channels, assuring clarity and uniqueness, both to UTS customers and the general public; A particular attention must be paid about quantity and frequency of messages, to maintain low signal-to-noise ratio.*
HCI & operational support	*User interfaces should be periodically revised and analysed, in order to ensure that information is provided instantly in a clear and simple way to each specific decision-maker; the complexity of UTS management requires specific UTS management tools, in order to avoid confusion and misunderstandings both in control room and on site.*
Availability of procedures and plans	*Public utilities in charge of managing the different city transport systems need to be forced to produce and share easy-to-understand procedures explaining the behaviour of their UTS in case of emergency.*
Conditions of work	*A proper UTS personnel shift and timetable scheduling need to be organized in the planning phase, by reducing as much as possible stressing conditions, and by rotating personnel as possible given the emergency conditions.*
Number of goals and conflict resolution	*After UTS crisis solutions a proper assessment need to be implemented, improving procedures leading to re-adaptation, re-routing, and when necessary to service shutdown.*

Interdependencies Recommendations

The coordination of UTS during emergency is executed under critical circumstances, where decisions may imply serious consequences on city transport and mobility services, not to mention human lives and properties. Decisional process must remain under a clear responsibility, at the higher level required. Emergency coordination and the consequent actions on UTS configuration need to be performed in very strict scheduling therefore a short time to reaction – together with the complexity of actions on the transport systems, may limit the capability to act effectively.

Abstract

Granting coordination of emergency actions in UTS with consequent redirection or shutdown of service

Background

UTS reconfiguration, UTS shutdown, and evacuation of people are concepts that must be considered in an escalation, but in reality they might be all present in a pragmatic (and not rarely dramatic) mix of emergency actions to be coordinated. Consequently, UTS operational status can be evaluated in significantly different manners, according to the gravity of the emergency event.

Examples

Albay Province, Philippines Risk Reduction case.

Municipal intervention in Torrigiani collapse in Florence.

Limitations

Poor security culture and awareness in travellers and UTS staff.

Communication gaps among the different UTS actors.

General Recommendations

Goal of the function is the restoration of routine UTS activities that were disrupted at a differing scale. The function encompasses activities planned before disruption (such as a Disruption Recovery Plan) and those improvised after a large-scale unforeseeable incident.
The function must have sufficient resources available, at least for short-term recovery at an acceptable level. It aims restoring urban transport services to their initial level. The restoration of modal services enables cross-modal network operations of the transport system as a whole.

Common Conditions Recommendations

Availability of resources	*<u>Human skills & competences</u>: collection of expertise, profound knowledge of UTS operations, <u>Budget</u>: prior budgeting allocated to restore-priorities, <u>Data & Algorithm</u>: standardized documentation of requirements & models*
Training & experience	*Coordination skills and expertise to conduct restore activities. Periodic training sessions to update skills & competences.*
Quality of communication	*Efficient, understandable and accurate coordination through standardized communication tools, protocols and languages across involved actors.*
HCI & Operational Support	*Utilization of software tools to analyse data or impacts of operational strategies applicable to the disrupted transportation system and to support development of focused intervention plans.*
Availability of procedures & plans	*Open planning process to effectively outline the tactical and operational list of actions.*
Conditions of work	*Capacity to facilitate the cooperation among different actors during restore-activities and all the steps of the field operations.*
Number of goals & conflict resolution	*Prioritize and operationalize goals by KPIs re. to restoration of fully operational conditions that were disrupted by disaster impacts.*
Available time & time pressure	*depending on how crucial the operation is for the whole UTS, the pre-event recovery plan should define time-critical restoration activities. In a (chrono)logical order: transport demand recovery follows service restoration.*
Circadian rhythm & stress	*Consider minimum rest times for restore operations personnel to avoid mishaps.*
Team collaboration quality	*Adherence to the principles of collaborative planning.*
Quality & support of the organization	*Clear decision making process and alignment of responsibility.*

Interdependencies recommendations

- *This function must be activated having in view the Coordinate Service delivery function . This function should be started when the critical emergency is finished.*
- *-This function must communicate with the Manage awareness & usage behaviour function so that there is awareness about status of transport services and processes.*
- *This function should coordinate with the Restore/repair physical infrastructure function. Services to be restored after the restoration of the transport infrastructure.*
- *A pre-event recovery plan prioritizes transport services (links & nodes) to be restored. A target for the said function is 90% operability in the short-/mid- term. A dynamic KPI is the time needed up to 90% operability. A static resilience KPI measures the transport demand covered by alternate carriage capacity as percentage of the transport demand reduction due to the disruption.*

Abstract

The function pertains to rebuilding and repairing UTS services and processes. The goal of this function involves the restoration of normal service activities that were disrupted following disastrous incidents. It' s done by diverse persons and equipment and encompasses multiple activities. To achieve it, are necessary an availability of resources and a planning for short- & long-term recovery. This function is also highly dependent and connected to the (previous) restoring of cyber-physical iransport infrastructures.

Background

Long service interruptions of UTS subsystems can heavily impact the urban life-line and the economy (e.g. non-satisfied metro demand in closed line segments without potential detours).

Example

Attiko Metro (AM) line closure after malevolent attack – Athens, Greece

A disruption to the Athens metro service due to attacks is simulated with the Strategic Transport Model of AM. UTS resilience is assessed in cases of no transit alternative vs. bus bridging. Static resilience KPIs have been estimated.

Limitations

- *Missing Service Level Agreements between UTS operators*
- *Lack of available drivers or vehicles to replace disrupted services*

Collect event information

Anticipate	Monitor	Respond	**Learn**

General Recommendations

- Establish a knowledge base, at UTS organization level, to collect and record ongoing operational data.
- Identify informational needs at UTS organization level.
- Identify a set of information sources sufficiently large and various to reflect the span and sweep of the UTS organization's interests.
- Including, in the information acquisition planning, the creation and coordination of a distributed network for information collection.
- Representing and indexing the unstructured information to simplify the retrieval of information that best answer a query.

Common Conditions Recommendations

Availability of resources	*Financial reserves for updating or acquiring ICT systems to improve data and information collection, integration and sharing.*
Training and experience	*Technological, psychology and cooperation skilla*
Quality of communication	*Stable technological communication channels, even with other interconnected critical infrastructures*
HCI & operational support	*Many interactions during emergency management, depending on the different ICT systems used and the cooperation among operators*
Availability of procedures and plans	*procedures and plans regarding the cooperation between UTS and other emergency operators*
Conditions of work	*Providing legislation to ensure the cooperation among different stakeholders and storage of shared data/information into a comprehensive knowledge base*
Number of goals and conflict resolution	*Detailed report of the data and information stored into the knowledge base*
Available time and time pressure	*Hands-on training sessions for technical personnel to support and keep up-to-date the data/information integration procedures*
Team collaboration quality	*Involvement of psychology and social/human science experts to acquire useful information from what users/citizens report*
Quality and support of the organization	*Clear plan for cooperation and information sharing with other relevant stakeholders*

Independencies Recommendations

- Data are related to different actors and technological systems involved during all the phases of the prepare-absorb-recover-adapt process.
- To maximize the internal data availability, a dedicated procedure, wide information and a specific ICT infrastructure should be put in place to favorite data transfer among different functions.

Abstract

Data coming from in-house and external sources should be considered to have a comprehensive overview of the event and the response of the UTS

Background

Information management is devoted to harness the information resources and information capabilities of the UTS to enable the organization to learn and adapt to its changing environment

Example

B. Hardjono, A. Wibisono, A. Nurhadiyatna, I.Sina and W. Jatmiko "Virtual Detection Zone in smart phone, with CCTV, and Twitter as part of an Integrated ITS", INTERNATIONAL JOURNAL ON SMART SENSING AND INTELLIGENT SYSTEMS VOL. 6, NO. 5, 2013.

Limitations

Post-event stress could make difficult to collect reliable and consistent information about the event from involved citizens/users.

Provide adaptation & improvement insights

Anticipate	Monitor	Respond	**Learn**

General Recommendations

- Ordinary stresses as well as emergency situations must be analyzed.
- The most intrinsic robustness of an UTS comes from continuous listening to the public, both the commuters and the occasional visitors
- Feedback must be shared with other UTS with the aim to enforce the diffusion of good practices.

Common Conditions Recommendations

Availability of resources	*Adaptation might require relevant investment. Thus, the role of insurance of financial reserves for de-briefing activities is crucial.*
Training and experience	*Data analysis, network analysis, simulation, management & coordination, good practices.*
Quality of communication	*complete and clear share of knowledge, data and information among the different actors.*
HCI & operational support	*Software for data analysis, social media monitoring, "what if" scenario simulation.*
Availability of procedures and plans	*Planning process to implement the proposed adaptations: working groups management and economic/financial analysis for priorizing adaptation actions.*
Conditions of work	*sharing of data, information and evaluation at every level and multi-domain: social, economic, technological, infrastructural and service.*
Number of goals and conflict resolution	*Quantitative and qualitative measures about the expected impact of the application of the defined adaptations.*
Available time and time pressure	*Medium/long term goals related to the reduction of risk and possible impacts of disruptive events,*
Team collaboration quality	*Collaboration and cooperation are crucial for accurately address the analysis of data and information, the definition of adaptations and the evaluation of their potential impact.*
Quality and support of the organization	*Clear decision making process and alignment of responsibility Planning operations to implement adaptation of UTS according to budgetary constraints.*

Independencies Recommendations

- An effective adaptation can be only identified by considering relevant data about the event and possible budgetary constraints
- The current status of the UTS must be known to define the most suitable adaptation actions.
- Information about the service provisioning must be evaluated to estimate the possible variations of the level of service associated to the adaptation actions identified.

Abstract

The core activities associated to this function are related to the ex-post analysis of relevant events, involving all the relevant actors in a de-briefing. The final goal is to learn from past events how improve the overall resilience of the UTS.

Background

Learn from data is crucial for this function: ex-post analysis of the event, the operations performed and their timing, the comparison with good practices, permits to identify criticalities and define corrective actions to improve the adaptation of the UTS to similar events.

Example

Responding to climate impacts: railways between Copenhagen and Ringsted (DK), The Public Transport Authority, which has analyzed the track capacity, has carried out a climate change impact assessment leading to recommendations for robust adaptation with respect to the expected climate changes.

Limitations

Optimal adaptations could be too expensive making difficult their implementation