Tomas Bata University in Zlín
Faculty of Applied Informatics

Dynamic Resilience Evaluation of Interrelated Critical Infrastructure Subsystems

Critical Infrastructure Protection and Resilience Conference

14th-16th Oct 2019 | Milan Italy

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Agenda

- Project Introduction
- Cascading Impact Assessment in a Critical Infrastructure System
- Quantitative Evaluation of the Synergistic Effects of Failures in a Critical Infrastructure System
- Complex Approach to Assessing Resilience of Critical Infrastructure Elements

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Project Introduction

The aim of the project is a research in critical infrastructure (CI) resilience issues, focusing on the dynamic linkages and interconnection assessment in significant European sectors (energy, transport, and ICT) and their elements.

Description of the CI systems failure synergic effect and its influence on the impact prediction process and the determination of the dynamic assessment of Critical Infrastructure resilience.

Practical development and establishment of scheme for identifying land transportation CI elements, CI energy sector element, and ICT in the context of their interconnection and correlation and in relation to emergency preparedness of the territorial units.

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Project Introduction

1. Research on selected significant national Critical Infrastructure interconnection and correlation.

2. Research on the Critical Infrastructure elements failure synergic effect and its influence on effective detection and identification of potential threats in a situational overview.

3. Research on dynamic interconnection correlations evaluation in critical infrastructure in order to Critical Infrastructure interdependencies analysis and modelling.

4. Research on Critical Infrastructure dynamic resilience assessment in context of the need to improving the critical infrastructure protection and resilience in terms of potential impact on the system

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Project Introduction

5. Research on land transportation, electricity and ICT critical infrastructure elements designation in relation to their correlations, cascade, and synergistic effects.

6. Research on identification of critical infrastructure vulnerable points and their interfaces in context of resilience increasing process.

7. Results integration and methodological approach development for critical infrastructure integral resilience dynamic assessment related to municipality perspective.

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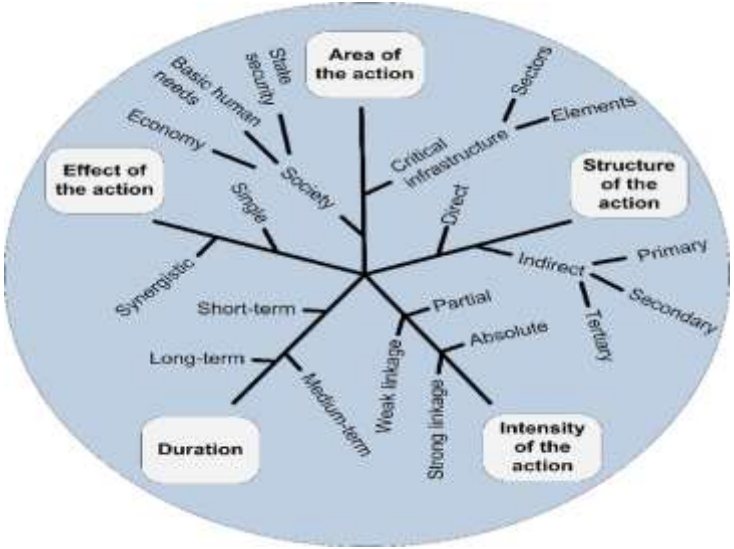
Cascading Impact Assessment in a Critical Infrastructure System



Aspects that create the nature of impacts on a CIS

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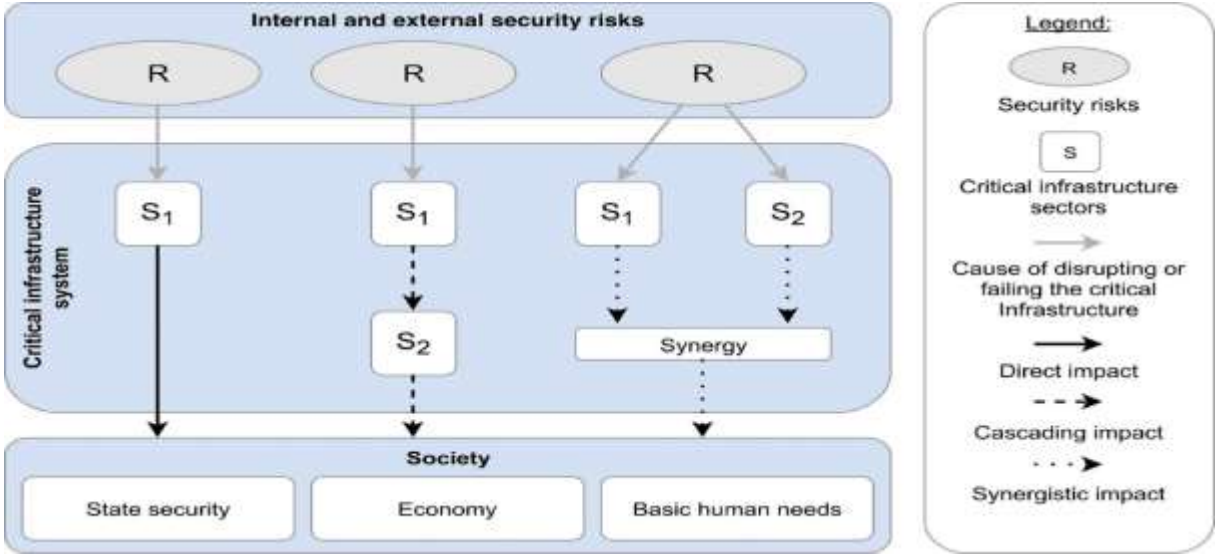
Cascading Impact Assessment in a Critical Infrastructure System



Ways of activities/spreads of impacts in a CIS

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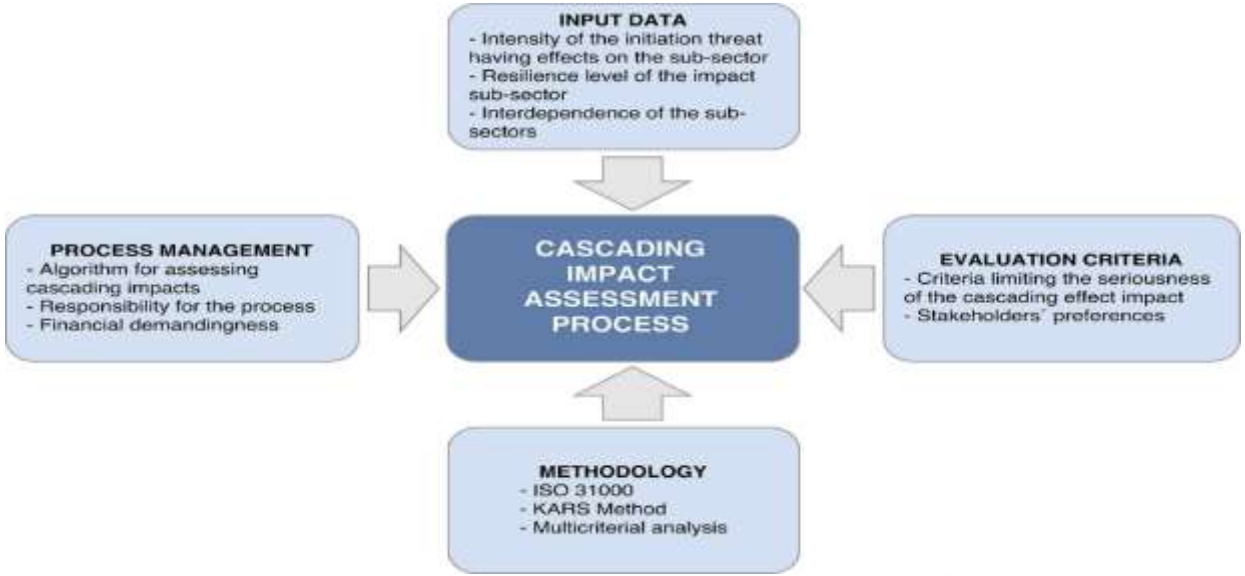

The Cascading Impacts Assessment Framework of a CIS

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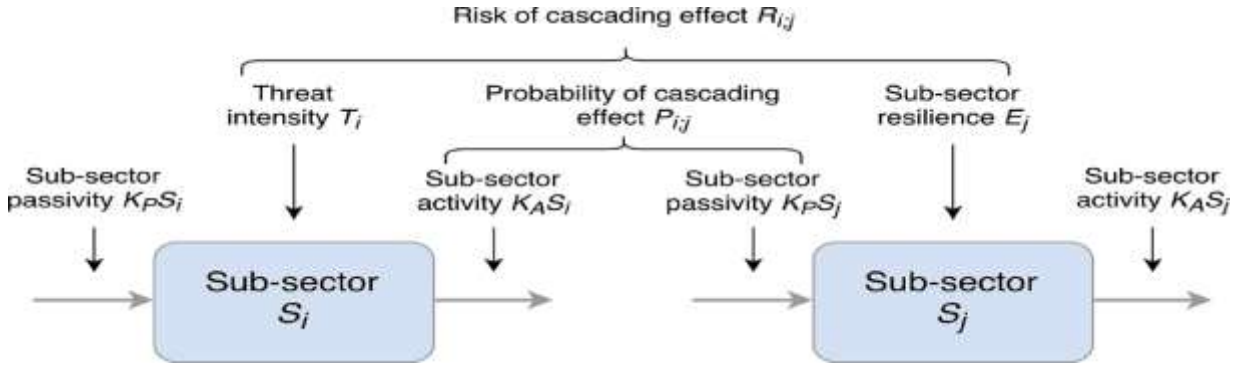
Cascading Impact Assessment in a Critical Infrastructure System



The Relation between Variables for Calculating the Cascading Effect Spread Risk

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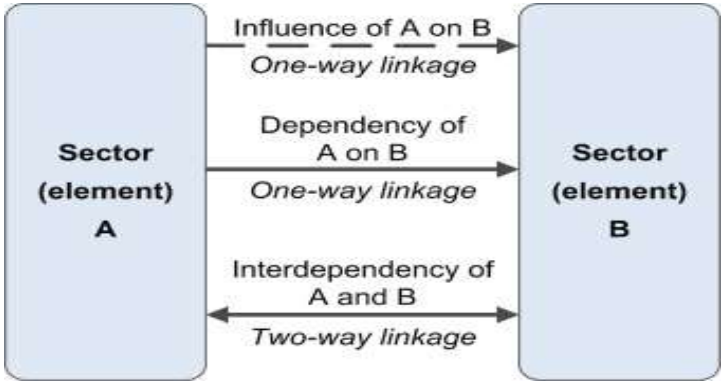
Quantitative Evaluation of the Synergistic Effects of Failures in a Critical Infrastructure System



Types of linkages in a critical infrastructure system

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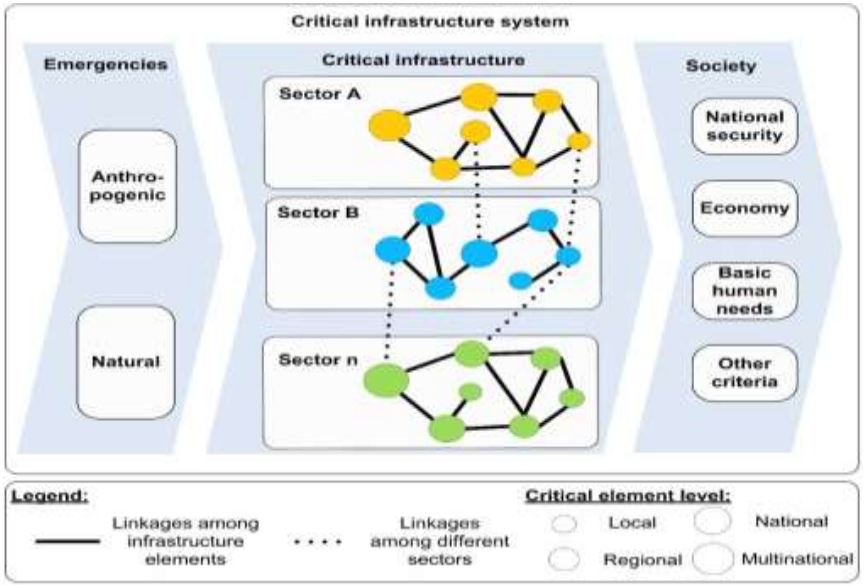

Grid organization of linkages in a critical infrastructure system

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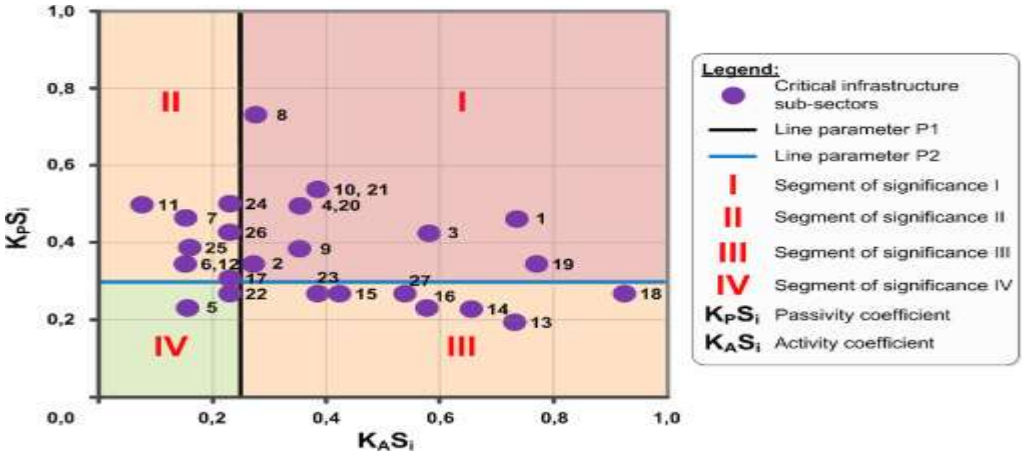

Graphical representation of sub-sector significance

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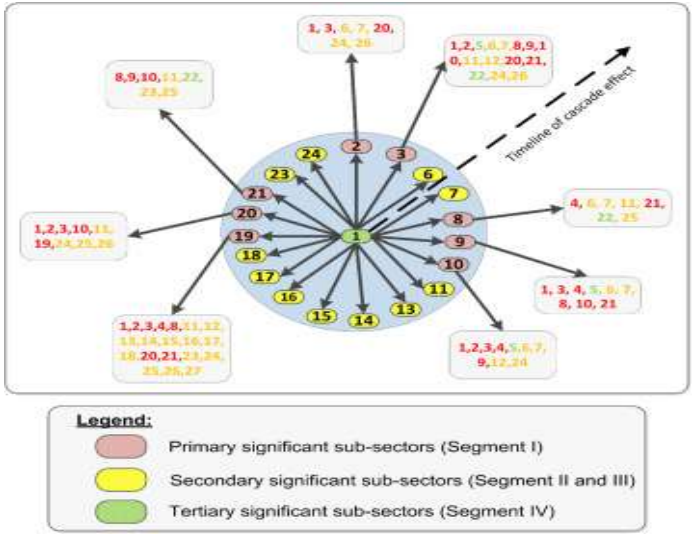

Visualization of selected sub-sector correlations

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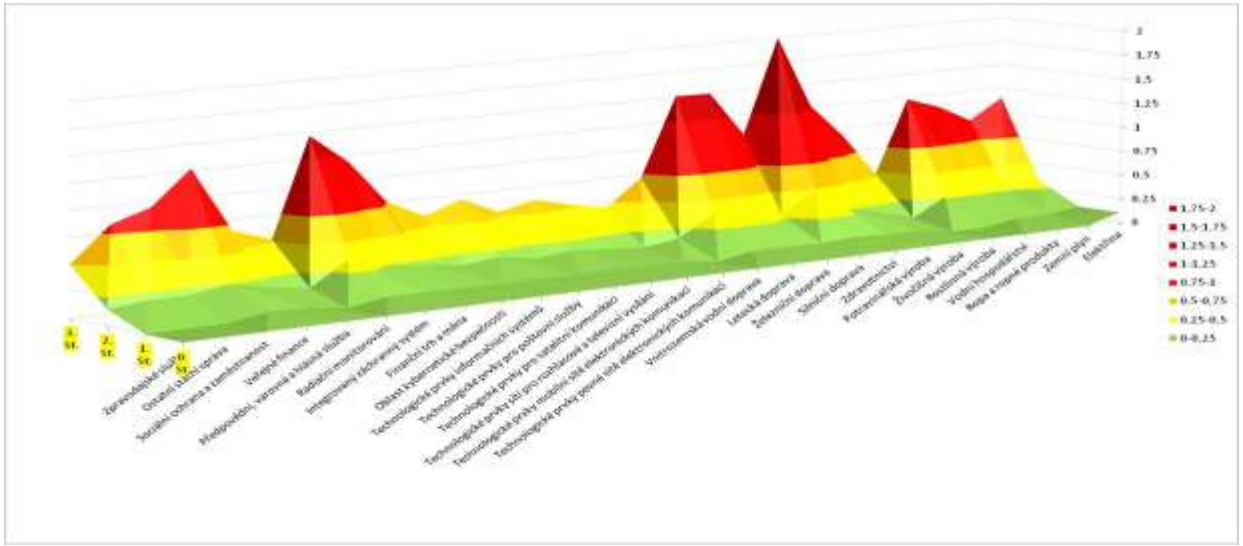

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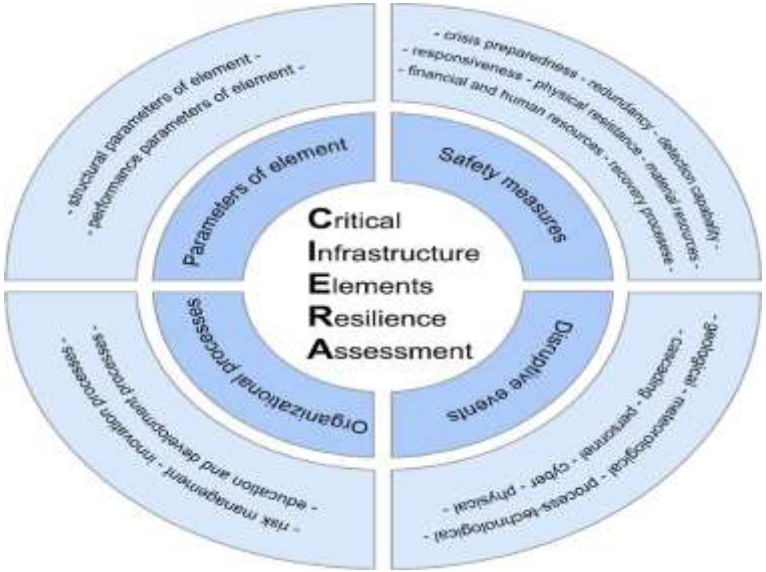
Complex Approach to Assessing Resilience of Critical Infrastructure Elements



Framework for assessing the resilience of critical infrastructure elements.

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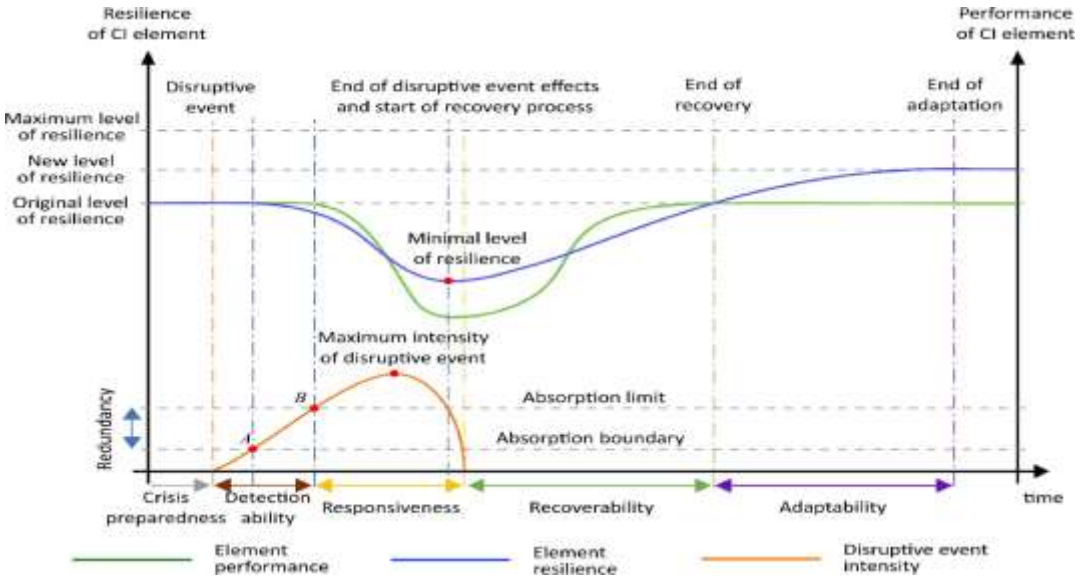

Graphical representation of components and variables determining the resilience of critical infrastructure elements

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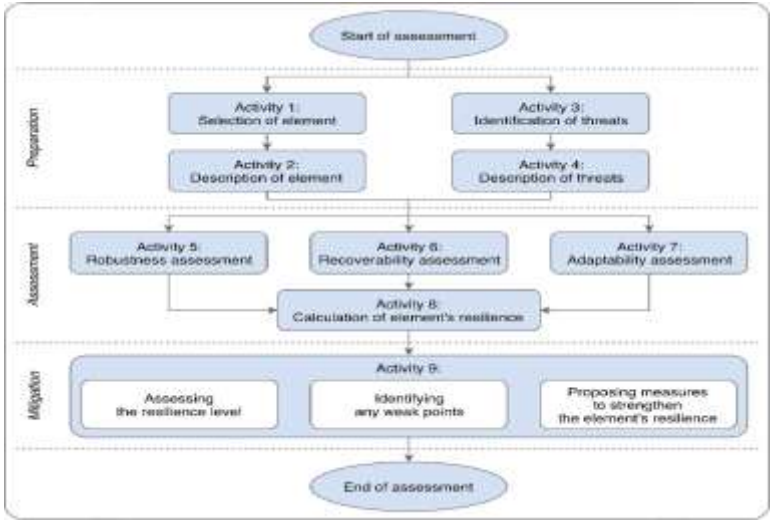

Procedure for assessing the resilience of critical infrastructure elements

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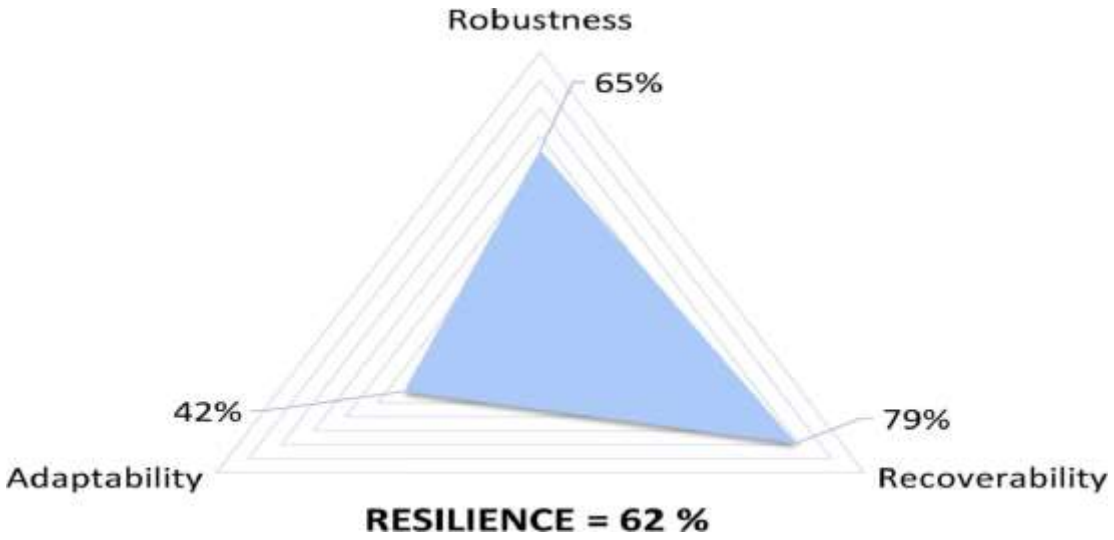

The resilience level of the critical infrastructure element

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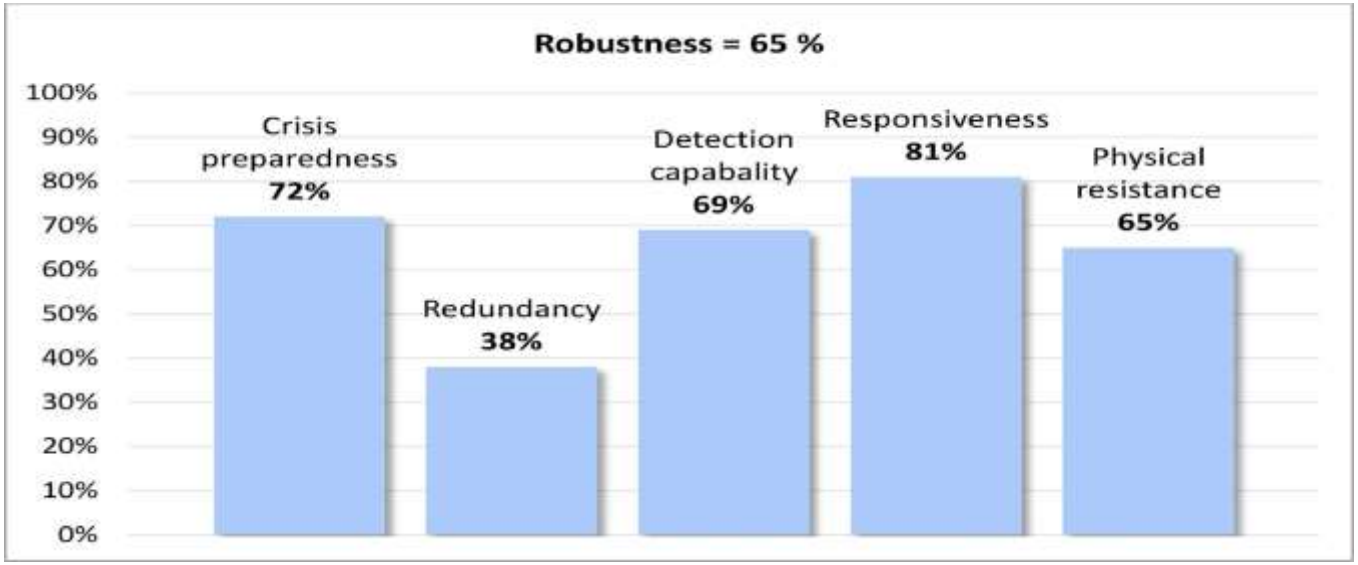

The robustness level of the critical infrastructure element

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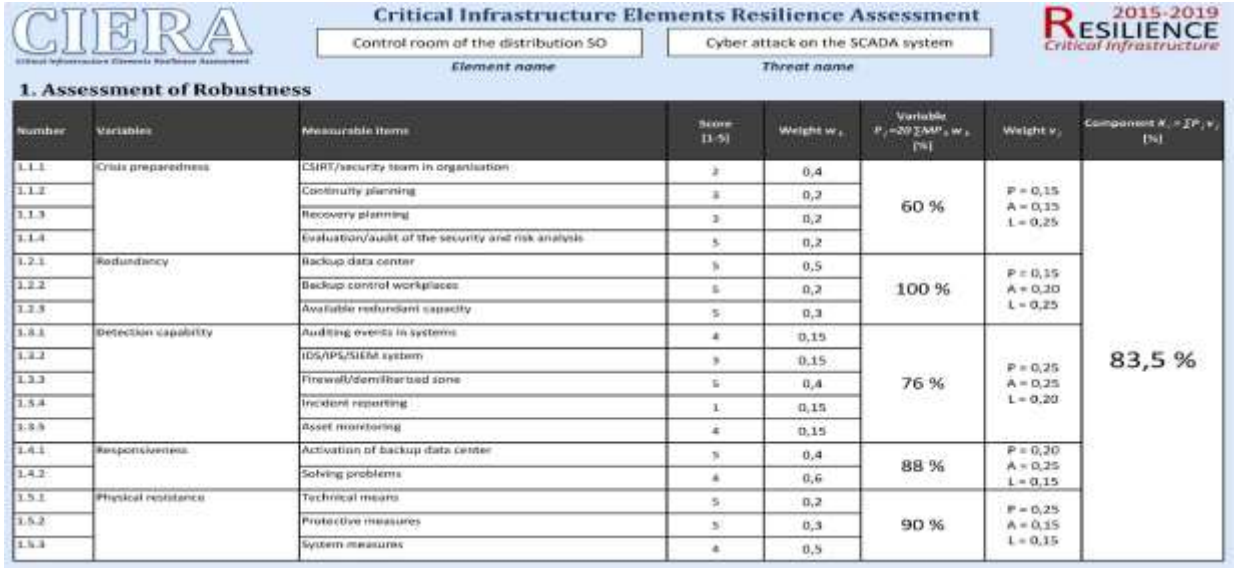

CIERA

Critical Infrastructure Elements Resilience Assessment

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Control room of the distribution SO — *Element name*

Cyber attack on the SCADA system — *Threat name*

1. Assessment of Robustness

Number	Variables	Measurable items	Score [1-5]	Weight w_i	Variable $P_j = 20 \sum MP_i \cdot w_i$ [%]	Weight v_j	Component $K_k = \sum P_j \cdot v_j$ [%]
1.1.1	Crisis preparedness	CSIRT/security team in organisation	2	0,4	60 %	P = 0,15 A = 0,15 L = 0,25	83,5 %
1.1.2		Continuity planning	3	0,2			
1.1.3		Recovery planning	3	0,2			
1.1.4		Evaluation/audit of the security and risk analysis	5	0,2			
1.2.1	Redundancy	Backup data center	5	0,5	100 %	P = 0,15 A = 0,20 L = 0,25	
1.2.2		Backup control workplaces	5	0,2			
1.2.3		Available redundant capacity	5	0,3			
1.3.1	Detection capability	Auditing events in systems	4	0,15	76 %	P = 0,25 A = 0,25 L = 0,20	
1.3.2		IDS/IPS/SIEM system	3	0,15			
1.3.3		Firewall/demilitarised zone	5	0,4			
1.3.4		Incident reporting	1	0,15			
1.3.5		Asset monitoring	4	0,15			
1.4.1	Responsiveness	Activation of backup data center	5	0,4	88 %	P = 0,20 A = 0,25 L = 0,15	
1.4.2		Solving problems	4	0,6			
1.5.1	Physical resistance	Technical means	5	0,2	90 %	P = 0,25 A = 0,15 L = 0,15	
1.5.2		Protective measures	5	0,3			
1.5.3		System measures	4	0,5			

Assessment of the element's robustness with respect to cyber-attacks

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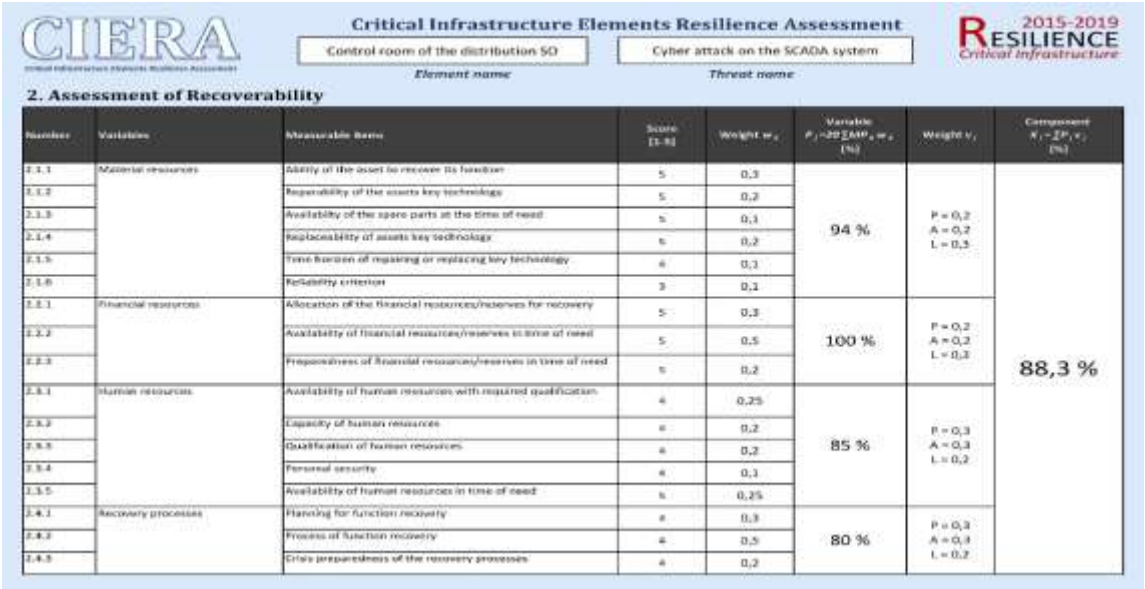

CIERA

Critical Infrastructure Elements Resilience Assessment

Control room of the distribution SO — *Element name*

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2. Assessment of Recoverability

Number	Variables	Measurable Items	Score [1-5]	Weight $w_{x,i}$	Variable $P_{x,i}=20\sum MP_{x,i} w_{x,i}$ [%]	Weight v_i	Component $K_i=\sum P_{x,i} v_i$ [%]
2.1.1	Material resources	Ability of the asset to recover its function	5	0,3	94 %	P = 0,2 A = 0,2 L = 0,3	88,3 %
2.1.2		Reparability of the assets key technology	5	0,2			
2.1.3		Availability of the spare parts at the time of need	5	0,1			
2.1.4		Replaceability of assets key technology	5	0,2			
2.1.5		Time horizon of repairing or replacing key technology	4	0,1			
2.1.6		Reliability criterion	3	0,1			
2.2.1	Financial resources	Allocation of the financial resources/reserves for recovery	5	0,3	100 %	P = 0,2 A = 0,2 L = 0,3	
2.2.2		Availability of financial resources/reserves in time of need	5	0,5			
2.2.3		Preparedness of financial resources/reserves in time of need	5	0,2			
2.3.1	Human resources	Availability of human resources with required qualification	4	0,25	85 %	P = 0,3 A = 0,3 L = 0,2	
2.3.2		Capacity of human resources	4	0,2			
2.3.3		Qualification of human resources	4	0,2			
2.3.4		Personal security	4	0,1			
2.3.5		Availability of human resources in time of need	5	0,25			
2.4.1	Recovery processes	Planning for function recovery	4	0,3	80 %	P = 0,3 A = 0,3 L = 0,2	
2.4.2		Process of function recovery	4	0,5			
2.4.3		Crisis preparedness of the recovery processes	4	0,2			

Assessment of the element's recoverability with respect to cyber-attacks

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Critical Infrastructure Elements Resilience Assessment

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3. Assessment of Adaptability

Number	Variables	Measurable items	Score [1-5]	Weight w_i	Variable $P_i = 20 \sum MP_i \cdot w_i$ [%]	Weight v_i	Component $K_i = \sum P_i \cdot v_i$ [%]
3.1.1	Risk management	Risk management level	2	0,4	34 %	0,4	58,6 %
3.1.2		Risk assessment methodology	1	0,2			
3.1.3		Implementation of security standards	1	0,1			
3.1.4		Level of scenarios for disruptive events	2	0,3			
3.2.1	Innovation processes	Organizational structure	1	0,1	60 %	0,3	
3.2.2		Implementation of management systems	2	0,1			
3.2.3		Management of organizational processes	1	0,1			
3.2.4		Innovation of management processes	2	0,1			
3.2.5		Technology innovation	4	0,2			
3.2.6		Innovation of security measures	4	0,2			
3.2.7		Research and development	1	0,1			
3.2.8		Innovation investment	5	0,1			
3.3.1	Education and development processes	Types of education provided or permitted by organization	5	0,2	90 %	0,3	
3.3.2		Scope of education	5	0,3			
3.3.3		Training to deal with the disruptive event	4	0,3			
3.3.4		Evaluation of the training's effectivity	4	0,2			

Assessment of the element's adaptability with respect to cyber-attacks

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