Critical infrastructure resilience index

JRC, Ispra

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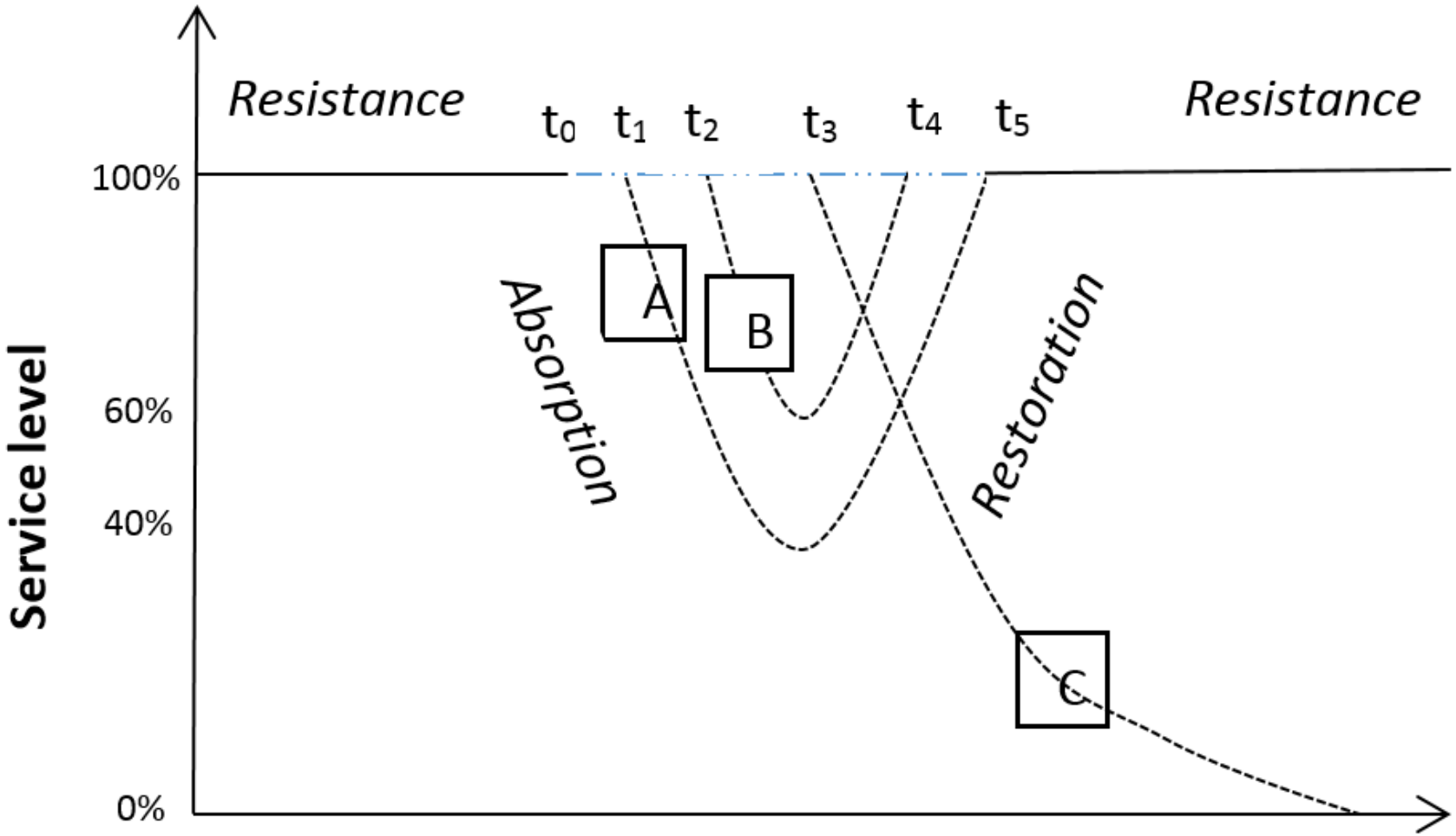
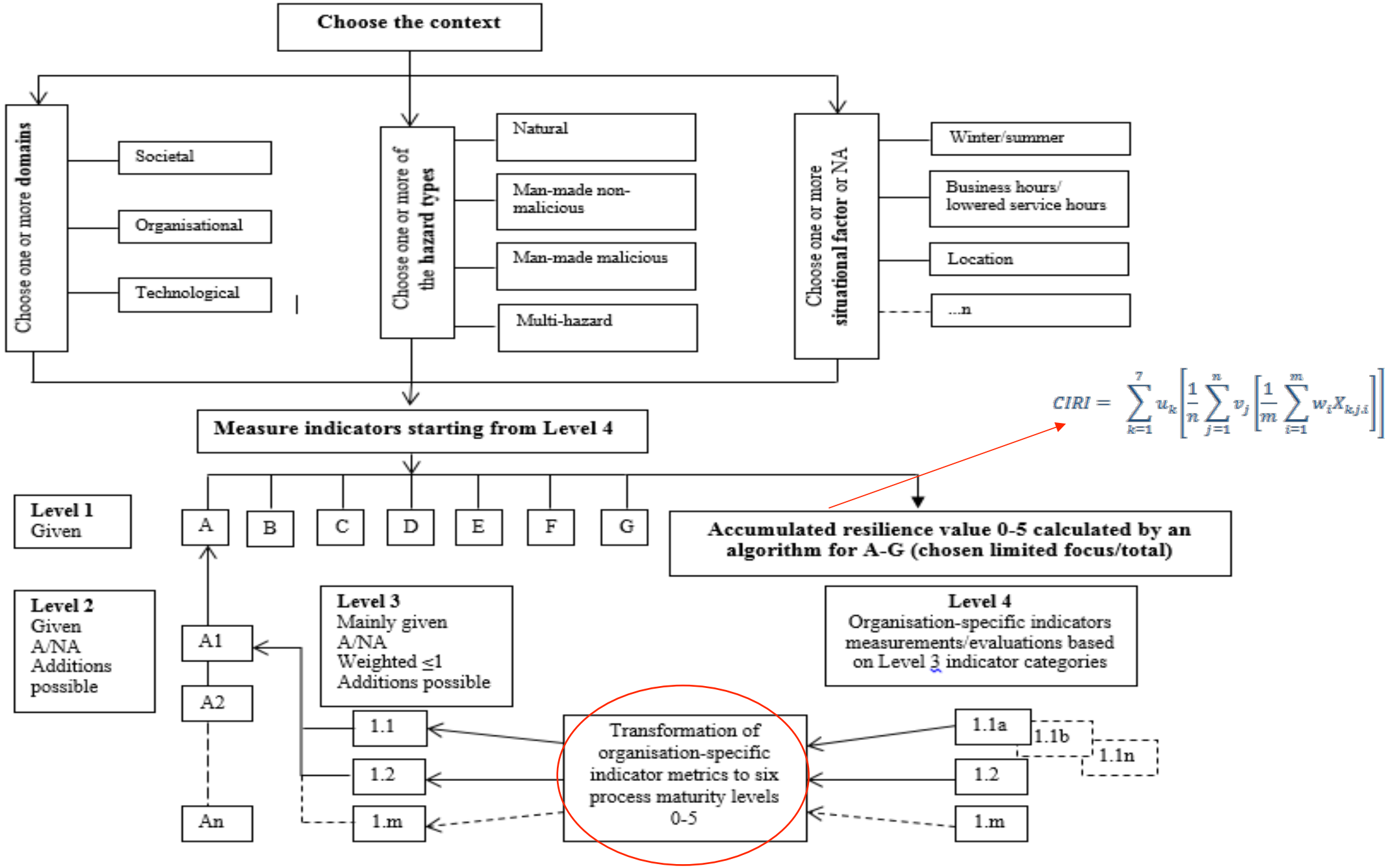
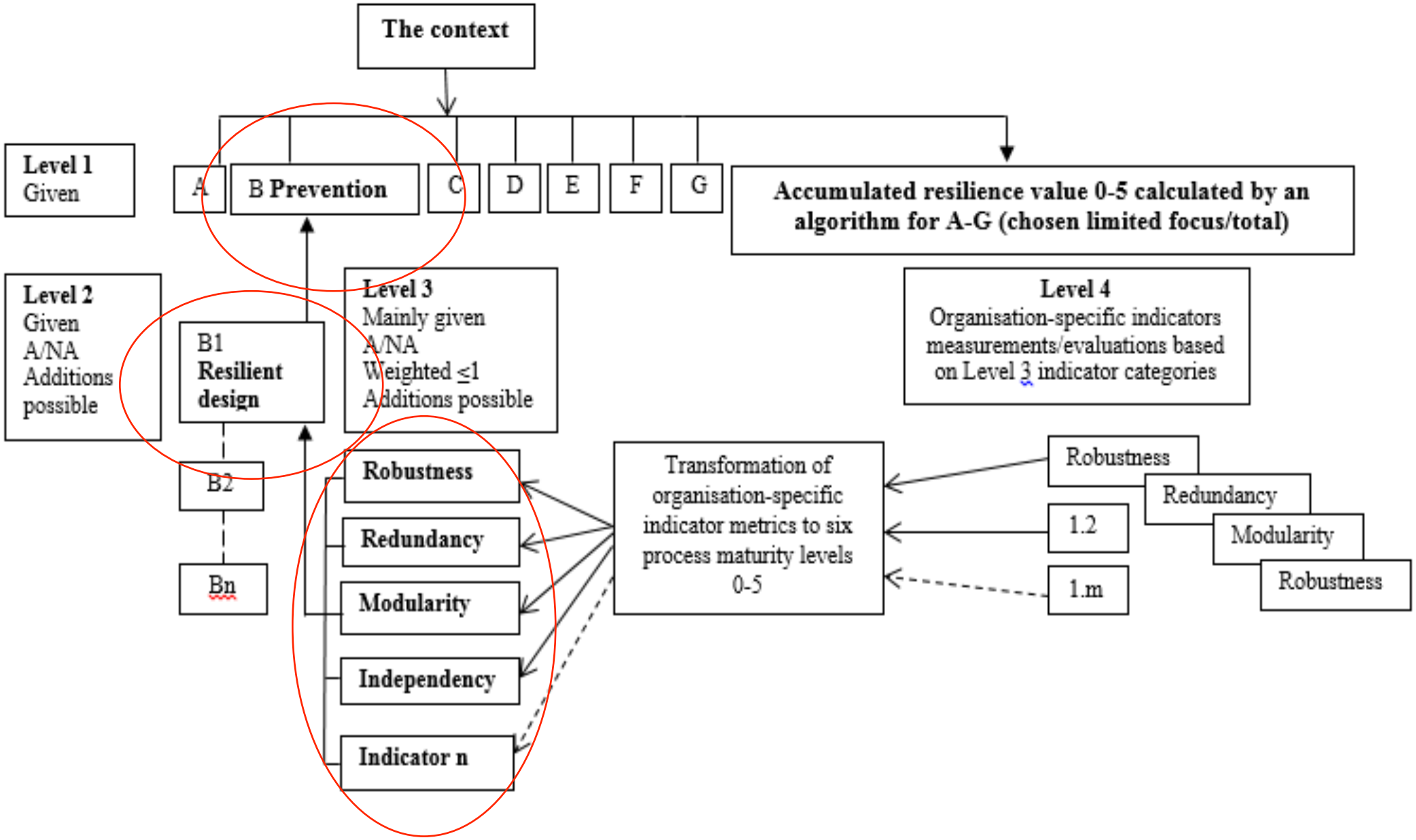
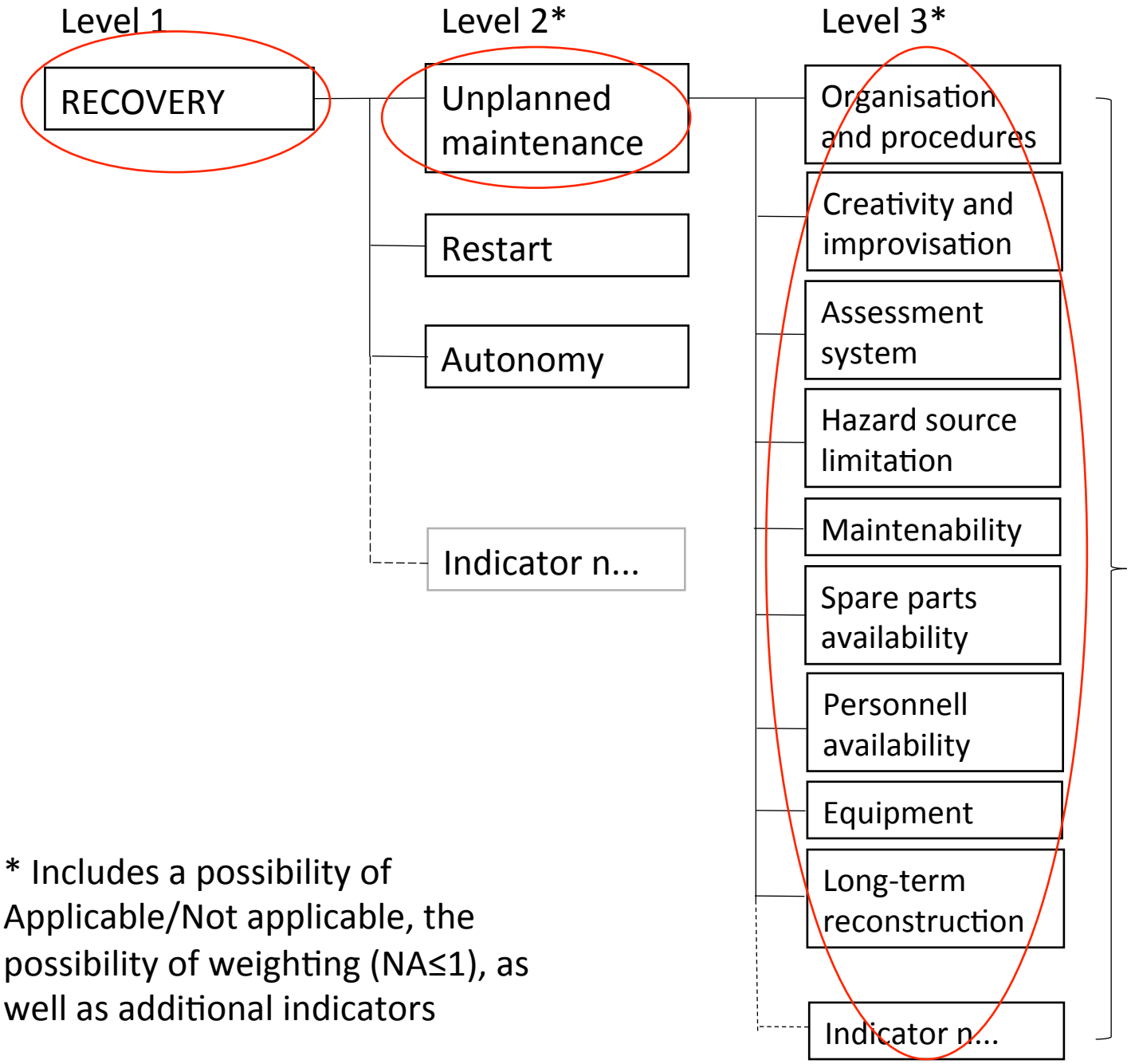

Resistance
Resistance
t0
t1
t2
t3
t4
t5
100%
60%
40%
0%
Service level
Absorption
A
B
Restoration
C


Preparedness
Monitoring, Early Warning & Warning
Prevention & Pre-crisis mitigation
Targeted resilience measures
Response, Post-event mitigation, Consequence management
Risk assessment
Learning, Post-crisis evaluation
Recovery, Restoration, Reconstruction

Risk assessment	**Prevention**	**Preparedness**	**Warning**	**Response**	**Recovery**	**Learning**
Failure data gathering	Safety and security culture	Preparedness plan and crisis organisation	Monitoring	Situation awareness	Unplanned maintenance	Evaluation
Knowledge of the context	Risk treatment plan	Redundancy plan	Early warning and alarm	Decision-making	Restart	Institutional learning
Risk assessment procedure	Risk communication	Cooperation agreements (external resources)		Coordination (internal and external)	Autonomy	Implementation of lessons
Monitoring and review	Resilience plan	Capability building		Communication (internal and external)		Technological upgradability
Testing and simulation	Resilient design	Capacity building		Resource deployment		
	Pre-emptive maintenance	Technical supportability		Absorption/ damage limitation		
		External interoperability		Externalised redundancy		
		Stakeholder management				


Choose the context
Choose one or more domains
Societal
Organisational
Technological
Choose one or more of the hazard types
Natural
Man-made non-malicious
Man-made malicious
Multi-hazard
Choose one or more situational factor or NA
Winter/summer
Business hours/ lowered service hours
Location
...n
Measure indicators starting from Level 4
$CIRI = \sum_{k=1}^{7} u_k \left[\frac{1}{n} \sum_{j=1}^{n} v_j \left[\frac{1}{m} \sum_{i=1}^{m} w_i X_{kj,i} \right] \right]$
Level 1
Given
A
B
C
D
E
F
G
Accumulated resilience value 0-5 calculated by an algorithm for A-G (chosen limited focus/total)
Level 2
Given
A/NA
Additions possible
A1
A2
An
Level 3
Mainly given
A/NA
Weighted ≤1
Additions possible
1.1
1.2
1.m
Transformation of organisation-specific indicator metrics to six process maturity levels 0-5
Level 4
Organisation-specific indicators measurements/evaluations based on Level 3 indicator categories
1.1a
1.1b
1.1n
1.2
1.m


The context
Level 1
Given
A
B Prevention
C
D
E
F
G
Accumulated resilience value 0-5 calculated by an algorithm for A-G (chosen limited focus/total)
Level 2
Given
A/NA
Additions possible
B1
Resilient design
B2
Bn
Level 3
Mainly given
A/NA
Weighted ≤1
Additions possible
Robustness
Redundancy
Modularity
Independency
Indicator n
Level 4
Organisation-specific indicators measurements/evaluations based on Level 3 indicator categories
Transformation of organisation-specific indicator metrics to six process maturity levels 0-5
Robustness
1.2
1.m
Robustness
Redundancy
Modularity
Robustness

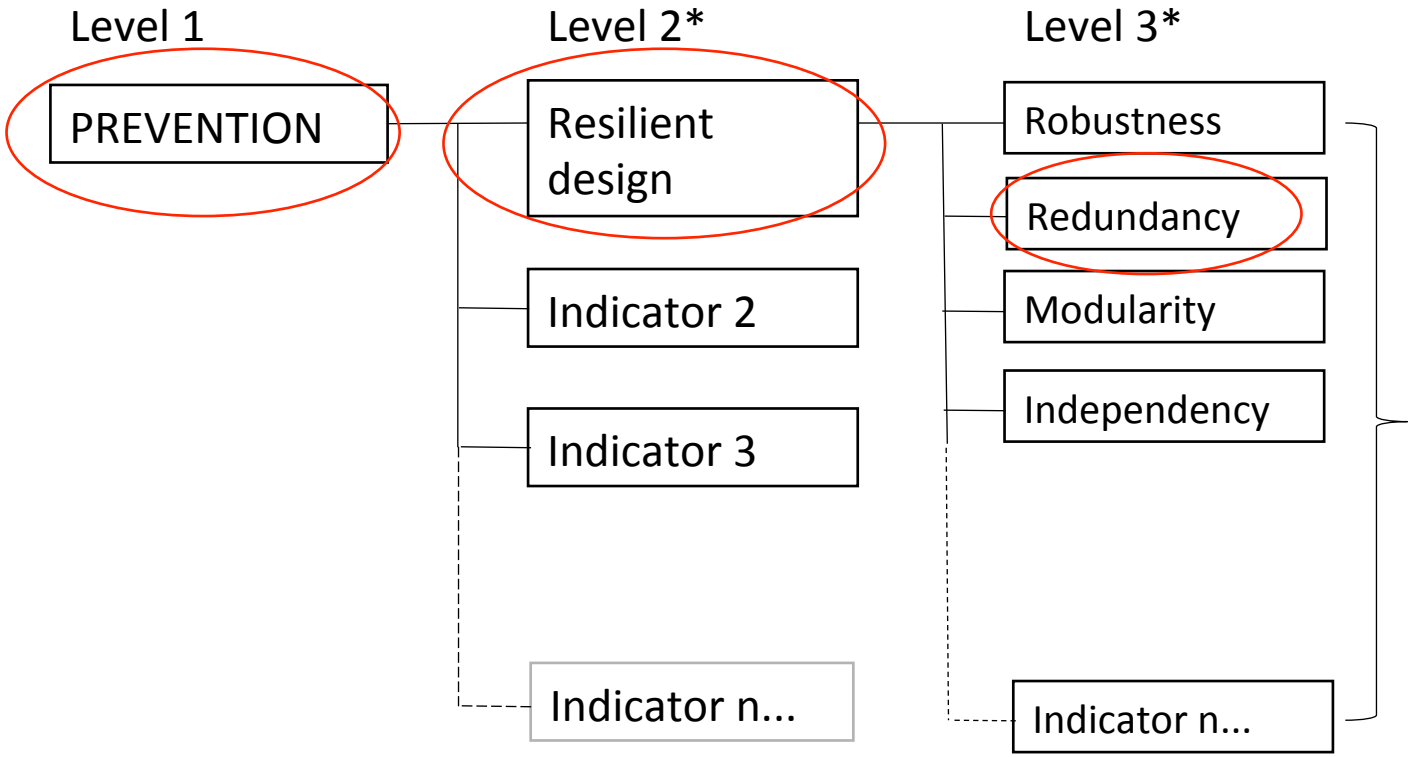


Level 4

Level 3 metrics		Level 4 metrics
0	Non-existent	Specific metrics for any indicator is transformed into processes, procedures, series of actions, series of operations, schemes, methods, or systems, corresponding one of the maturity levels 0-5.
1	Initial/Ad Hoc	
2	Repeatable but Intuitive	
3	Defined Process	
4	Managed and Measurable	
5	Optimised	

* Includes a possibility of Applicable/Not applicable, the possibility of weighting (NA≤1), as well as additional indicators

Level 3 metrics			Level 4 metrics
0	**Non-existent**	Complete lack of any recognisable processes. The organisation has not even recognised that there is an issue to be addressed.	**Specific metrics for any quantitative, semi-quantitative or qualitative indicator is transformed into processes, procedures, series of actions, series of operations, schemes, methods, or systems, corresponding one of the maturity levels 0-5.** *Cobit process maturity scale
1	**Initial/Ad Hoc**	There is evidence that the organisation has recognised that the issues exist and need to be addressed. There are, however, no standardised processes; instead, there are *ad hoc* approaches that tend to be applied on an individual or case-by-case basis. The overall approach to management is disorganised.	
2	**Repeatable but Intuitive**	Processes have developed to the stage where similar procedures are followed by different people undertaking the same task. There is no formal training or communication of standard procedures, and responsibility is left to the individual. There is a high degree of reliance on the knowledge of individuals and, therefore, errors are likely.	
3	**Defined Process**	Procedures have been standardised and documented, and communicated through training. It is mandated that these processes should be followed; however, it is unlikely that deviations will be detected. The procedures themselves are not sophisticated but are the formalisation of existing practices.	
4	**Managed and Measurable**	Management monitors and measures compliance with procedures and takes action where processes appear not to be working effectively. Processes are under constant improvement and provide good practice. Automation and tools are used in a limited or fragmented way.	
5	**Optimised**	Processes have been refined to a level of good practice, based on the results of continuous improvement and maturity modelling with other organisation. IT is used in an integrated way to automate the workflow, providing tools to improve quality and effectiveness, making the organisation quick to adapt.	



Level 4

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2	**Repeatable but Intuitive**	
3	**Defined Process**	
4	**Managed and Measurable**	
5	**Optimised**	

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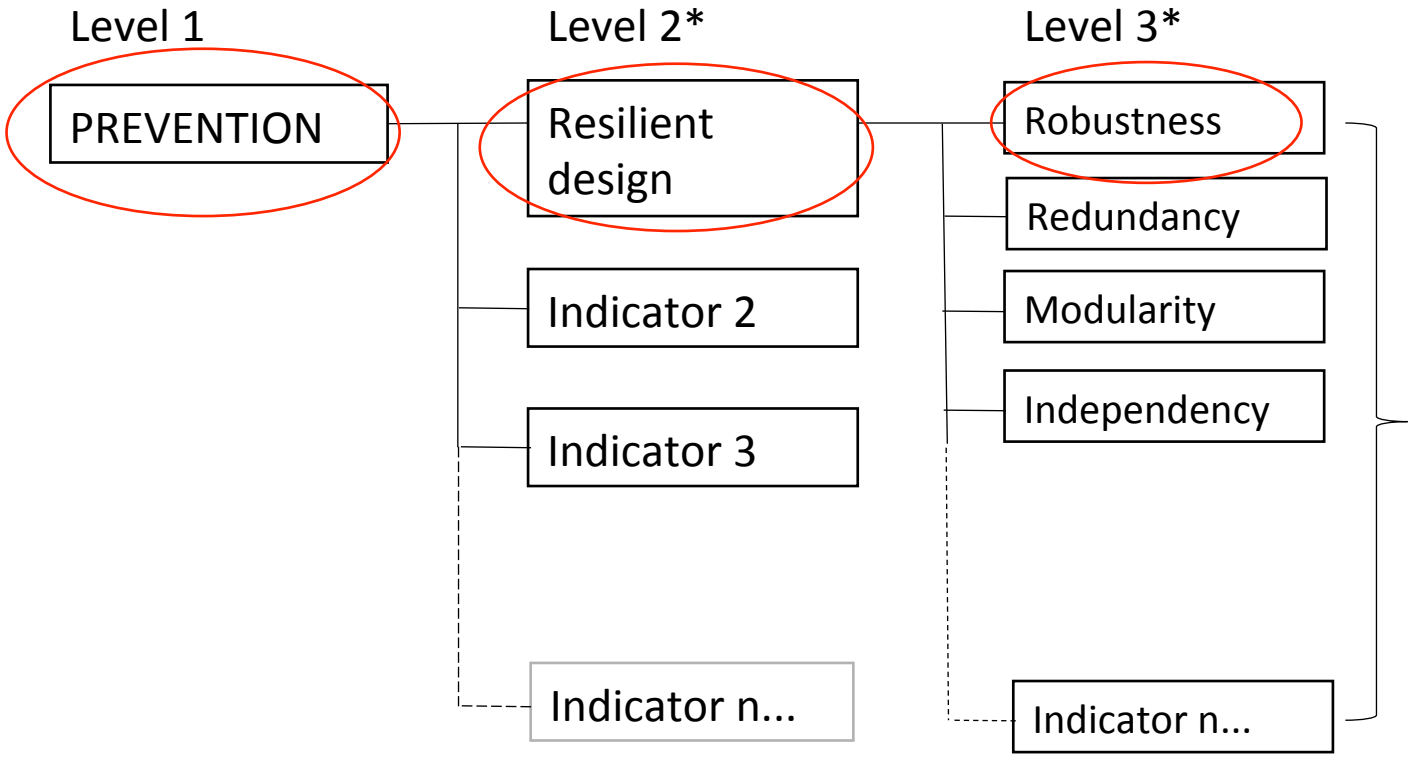
Example #1 of how to define Level 3 & 4 values*

Oslo Airport Gardermoen fuel logistics
L1 PREVENTION > L2 Resilient design > L3 Redundancy > L4 Reserve storage capacity

0	Service disrupted for more than 90 days	0 m^3 reserve storage capacity
1	Service disrupted for 30-90 days	38 630 to 4 600 m^3 reserve storage capacity
2	Service disrupted for 7-30 days	53 440 to 38 630 m^3 reserve storage capacity
3	Service disrupted for 3-7 days	56 020 to 53 440 m^3 reserve storage capacity
4	Service disrupted for less than 3 days	57 950 to 56 020 m^3 reserve storage capacity
5	No disruption to service	57 950 m^3 reserve storage capacity

*Based on Greg Baker's (SPFR, Norway) background paper for the Improver Project



Level 4

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2	**Repeatable but Intuitive**	
3	**Defined Process**	
4	**Managed and Measurable**	
5	**Optimised**	

* Includes a possibility of Applicable/Not applicable, the possibility of weighting (NA≤1), as well as additional indicators

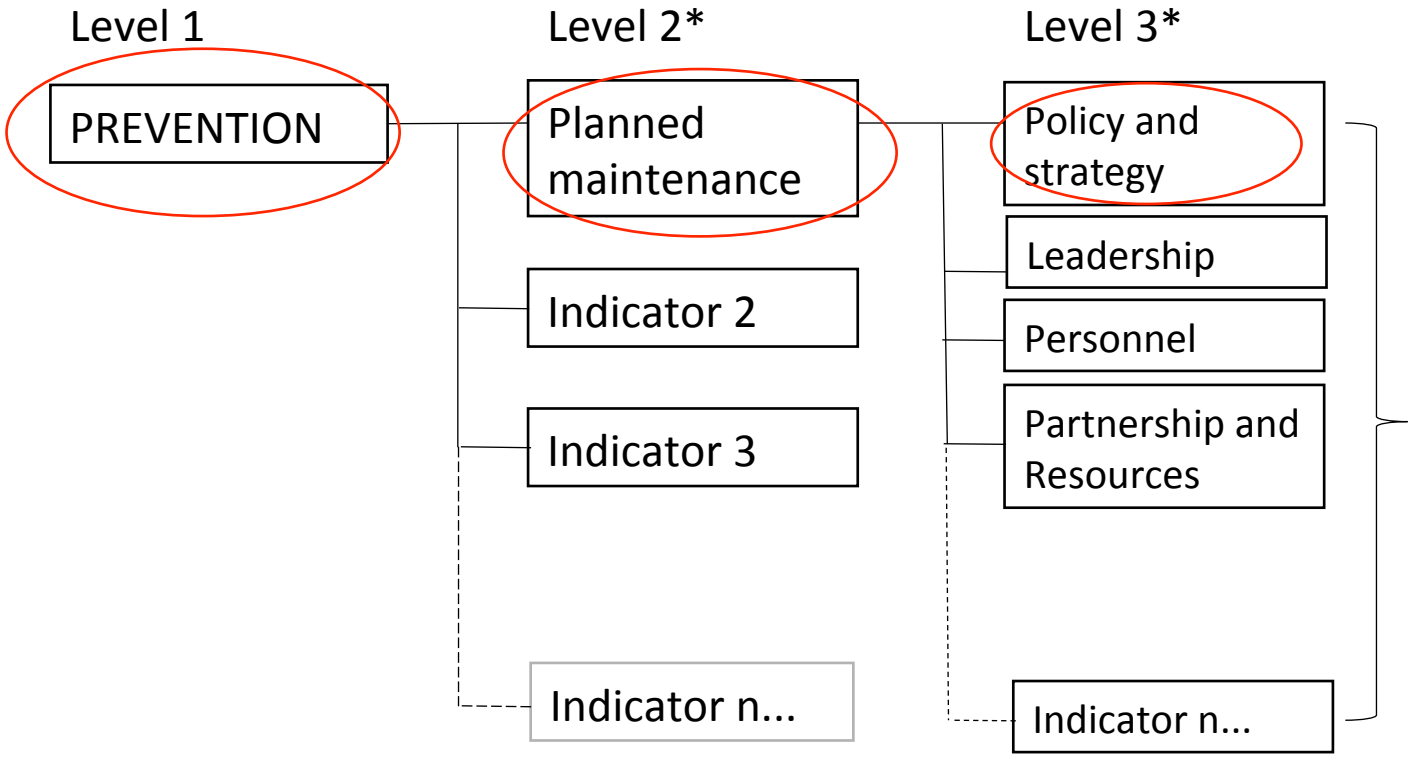
Example #2 of how to define Level 3 & 4 values*

Seismic design capacity of a free-standing transmission tower
L1 PREVENTION > L2 Resilient design > L3 Robustness > L4 ASC/MSDC

0	Service disrupted for more than 48 hours	ASC < 0.5MSDC
1	Service disrupted for 24-48 hours	0.5MSDC < ASC < 0.75MSDC
2	Service disrupted for less than 24 hours	0.75MSDC < ASC < 1.0MSDC
3	Service disrupted for less than 12 hours	ASC = MSDC
4	Service disrupted for less than 1 hour	1.0MSDC < ASC < 1.25MSDC
5	No disruption to service	1.25MSDC < ASC

MSDC = Mandatory Structural Design Capacity
ASC = Actual Structural Capacity

*Based on Greg Baker's (SPFR, Norway) background paper for the Improver Project



Level 4

Level 3 metrics		Level 4 metrics
0	**Non-existent**	Specific metrics for any indicator is transformed into processes, procedures, series of actions, series of operations, schemes, methods, or systems, corresponding one of the maturity levels 0-5.
1	**Initial/Ad Hoc**	
2	**Repeatable but Intuitive**	
3	**Defined Process**	
4	**Managed and Measurable**	
5	**Optimised**	

* Includes a possibility of Applicable/Not applicable, the possibility of weighting (NA≤1), as well as additional indicators

Example #3 of how to define Level 3 (& 4) values*

Seismic design capacity of a free-standing transmission tower
L1 PREVENTION > L2 Planned maintenance > L3 Policy and strategy > L4 Qualitative evaluation

0		Non-existent
1	Initial /Ad-hoc	Reactive execution and on purpose
2	Repeatable and intuitive	Establish and maintaining the mission, policy and strategy to plan and perform the processes. Requirements are identified. Maintaining and validating the requirements with bidirectional communication. Activities prioritized according to the requirements. Performance objectives are established (including quality) according to definitions, procedures and standards. Service agreements are established and maintained for managing and delivering services.
3	Defined process	Process improvement opportunities are established and maintained. Essential resources and identified and prioritized. Plans and need for standard services are established. Known and tested solutions are defined to solve or prevent the known incidents.
4	Managed and Measurable	Encourage quantitative process-performance evaluation through benchmarking.
5	Optimized	Encourage the continuous improvement of processes and technologies towards a world class maintenance.

*Based on Bjarte Rød's (UiT, Norway) background paper for the Improver Project

Thank you for your attention!

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