

Beyond assessment of individual safety management and operational processes

a set of uniform and novel aviation safety metrics

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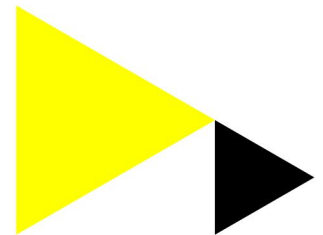
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BEYOND ASSESSMENT OF INDIVIDUAL SAFETY MANAGEMENT AND OPERATIONAL PROCESSES: A SET OF UNIFORM AND NOVEL AVIATION SAFETY METRICS

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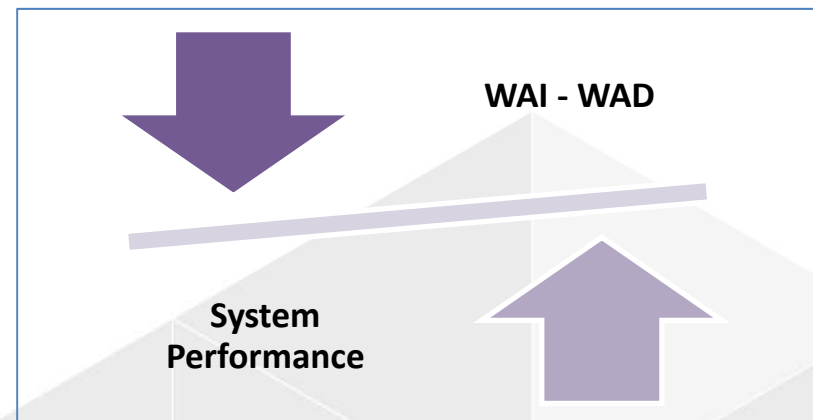
CHALLENGES FOR AVIATION COMPANIES

- **Small – Medium Enterprises:** lack of adequate safety/operational data to monitor safety
- **Large companies:** operational/safety data available, but they need leading metrics of better quality
- **How to move** from compliance-based to performance-based monitoring?

CURRENT SITUATION & PRACTICE

- **Safety metrics can be split into two groups:**
 - **Safety process metrics (proactive):** mostly compliance-based and SMS activities volume-based approaches
 - **Safety outcome metrics (reactive):** ambiguity in thresholds of (serious) incidents does not allow their reliable and uniform use in safety performance measurement
- **Current safety metrics** lie on the safety viewpoint adopted, mainly linear
- **There is no consistent linear relationship** between current metrics of safety processes and outcomes
- **No quality criteria** are used for developing safety metrics

OUR APPROACH



- In practice, the industry considers the gaps, **but we haven't uniformly depicted/measured those and searched for their effects**
- We focus on the gaps; we do **not claim authenticity of either WAD or WAI**
- **Operationalisation of concepts** discussed but not yet used
- **Safety is not the only system objective**

METRIC 1: SMS ASSESSMENT

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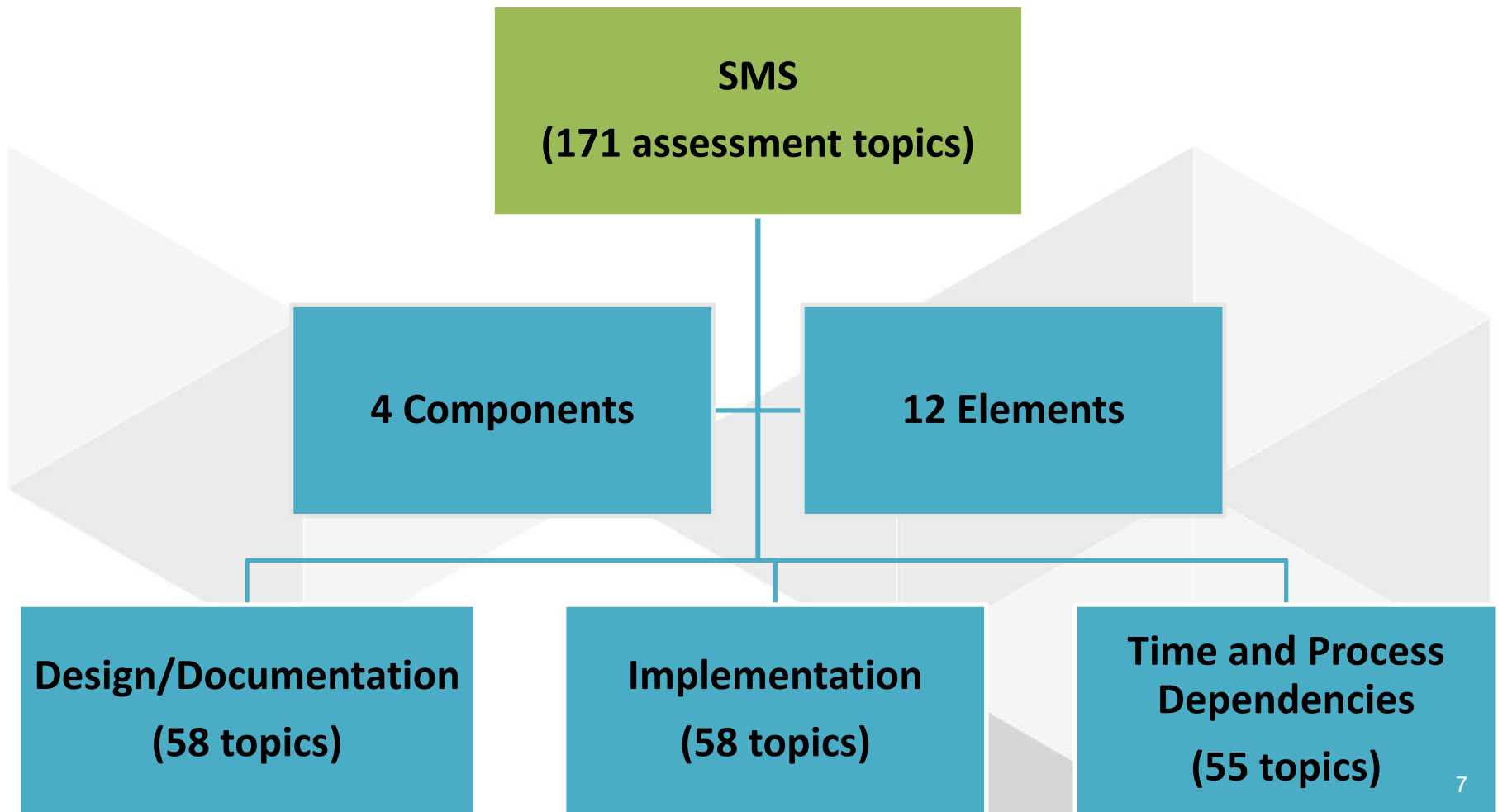




OVERALL CONCEPT

**SMS Performance =
SMS Functioning * SMS Delivery Quality**

SMS FUNCTIONING BREAKDOWN

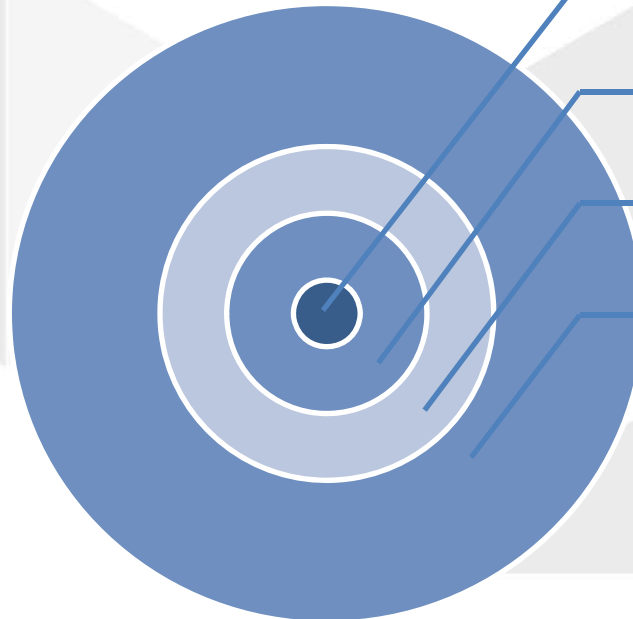


SMS ASSESSMENT TOPICS AND SCORING

ASSESSMENT OF THE EXTENT TO WHICH SMS FUNCTIONS ACCORDING TO STANDARDS				
SMS component	SMS element	Code	Check if:	Extent of Realising the Requirement
		MCR1	There is a safety policy	100%
		MCR2	The organisational policy views safety as core business function	70%
		MCR3	Safety personnel participate in all management meetings across different organizational levels	100%
		MCR4	Safety is a parameter during decision-making during all management meetings across different organizational levels	70%
		MCR5	Possible need to change the safety policy has been always discussed during significant changes within the organization (e.g., overall business objectives) or of external conditions	20%
		MCR6	Current safety policy is included in all safety education/training programs	0%

SMS DELIVERY QUALITY: QUESTIONS

How capable do you feel of executing your activities included in this element?	How adequate are the means provided to you to execute the activities included in this element?	To what degree do you conflict with other persons that work on the same activities included in this element?	How adequate are any external resources/products you need to execute your activities included in this element?	How timely are any necessary external resources/products delivered to you to execute the activities included in this element?	To what degree external factors disturb you in the execution of your activities included in this element?	To what degree do the outcomes of your activities included in this element meet the expected standard?	How timely do you execute your activities of the specific element when needed?
--	--	--	--	---	---	--	--



171 points

12 Elements

4 Components

SMS

SMS PERFORMANCE SCORE

SMS FUNCTIONING ACROSS COMPONENTS	Distance	Maximum	Function Score
Euclidean Distance of Current SMS from Ideal SMS with equal weights	1,98	2,00	1,13%
Euclidean Distance of Current SMS from Ideal SMS weighted according to the number of individual requirements included	94,20	97,07	2,95%

SMS DELIVERY QUALITY ACROSS COMPONENTS	Distance	Maximum	Delivery Quality Score	Total SMS Score
Euclidean Distance of Current SMS from Ideal SMS with equal weights	2.00	2.00	0.00%	0
Euclidean Distance of Current SMS from Ideal SMS weighted according to the number of individual activities included	776.58	776.58	0.00%	0

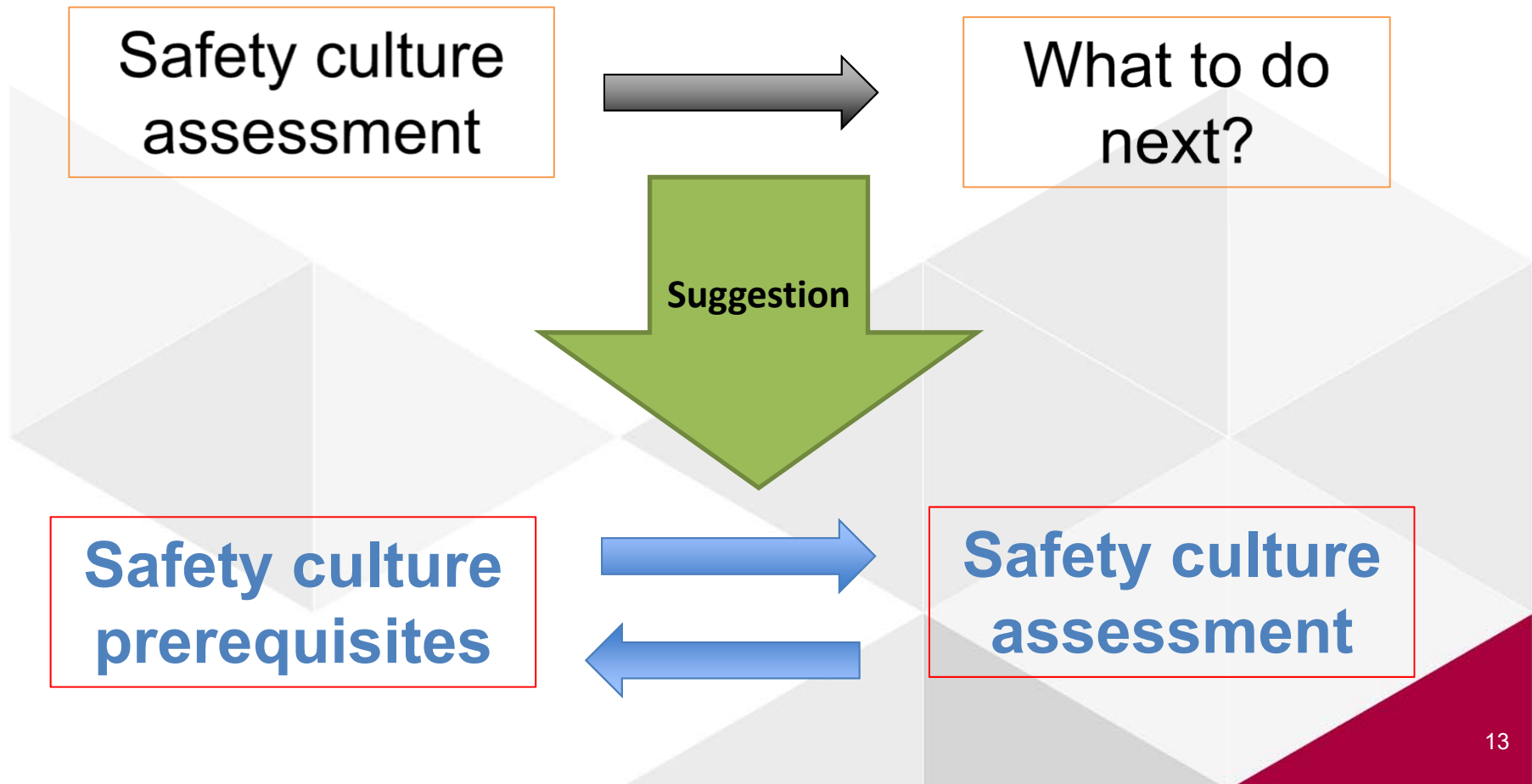
SMS ASSESSMENT: CUSTOMIZATION TO SIZE AND COMPLEXITY OF COMPANY

	Checking points (Deskwork): SMS design and implementation		
Survey questions to staff: SMS delivery quality	171 (58 design points, 58 implementation points, 55 "dependency" points)	36 12 SMS elements * (1 design + 1 implementation +1 dependency question/point)	12 4 SMS components * (1 design + 1 implementation +1 dependency question/point)
96 (8 questions per element * 12 SMS elements)	Part CAT (Option 1)	N/A	N/A
32 (8 questions per component * 4 SMS components)	Part CAT (Option 2)	Complex – Part NCC (Option 1)	N/A
8 Each of the 8 questions referring to the whole SMS	N/A	Complex – Part NCC (Option 2)	Non Complex – Part NCC

METRIC 2: SAFETY CULTURE PREREQUISITES



OVERALL CONCEPT



PREREQUISITES: DESIGN/DOCUMENTATION

1		Document Analysis	Please choose from dropdown	Reference	Score
5	G.3-1	Responsibilities for safety have been defined across all management areas.	Partially		50 G
6	G.3-2	Accountabilities for safety have been defined across all management areas.	Partially		50 G
7	G.4-1	The safety department is responsible for safety planning.	Yes		100 G
		The safety department is accountable for safety			

PREREQUISITES: IMPLEMENTATION

	Survey	Please choose from dropdown	Score	
) G.6	To what extent do you continuously improve safety, regardless of past successes?	Sometimes	50	
) G.7-1	How often do you base decisions, changes and plans on a risk management framework?	Never	0	

PREREQUISITES: PERCEPTION & GAPS

	I think the culture in this organization is just		0

Culture		A. Document Analysis	B. Survey	C. Perception
General	General score	59,5	46,9	75,0
	Gap A - B	12,6		
	Gap B - C	28,1		
	Gap A - C	-15,5		

METRIC 3: SYSTEM COMPLEXITY/COUPLING





COMPLEXITY FACTORS

- Complexity cannot be fully understood
- Literature suggests various approaches to “measure” complexity for specific applications
- Our system complexity/coupling metric combines:
 - Number and timestamp of elements
 - Number and types of interactions
 - Resource slacks
 - User perception

COMPLEXITY/COUPLING FORMULAS

$$\text{SystemComplexity} = \left[\sum_{i=1}^{NE} \sum_{j=1}^{NI_i} (DI_{ij} * w_{ij}) \right] * SLacks$$

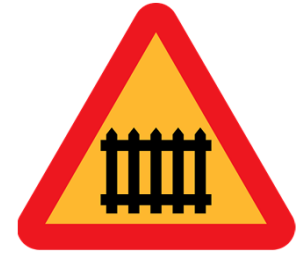
$$\text{where, } SL = T + HR + TR = \left(\frac{T_{needed}}{T_{available}} \right) + \left(\frac{HR_{needed}}{HR_{available}} \right) + \left(\frac{TR_{needed}}{TR_{available}} \right)$$

$$\begin{aligned} & \text{Total Complexity} \\ & = \text{SystemComplexity} * \text{HumanPerception} \end{aligned}$$

METRIC 4: RISK CONTROL EFFECTIVENESS

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INDICATORS

(WHEN RELIABLE DATA AVAILABLE)

Indicator 1: $\frac{\text{number of failures of control when challenged}}{\text{number of occasions the control was challenged}}$

Indicator 2: $\frac{\text{number of failures of control when tested}}{\text{number of occasions the control was tested}}$

Indicator 3: $\frac{\text{number of unwanted events after a control was implemented to prevent them}}{\text{number of unwanted events before a control was implemented}}$

The indicators above are listed in preferential order

SCORING OF RISK CONTROLS

(WHEN RELIABLE DATA UNAVAILABLE)

Functionality (Hollnagel, 2004)	Score	Hierarchy of controls (Leveson, 2011)	Score
Physical	4	Elimination	4
Functional	3	Prevention	3
Symbolic	2	Reduction	2
Incorporeal	1	Mitigation	1

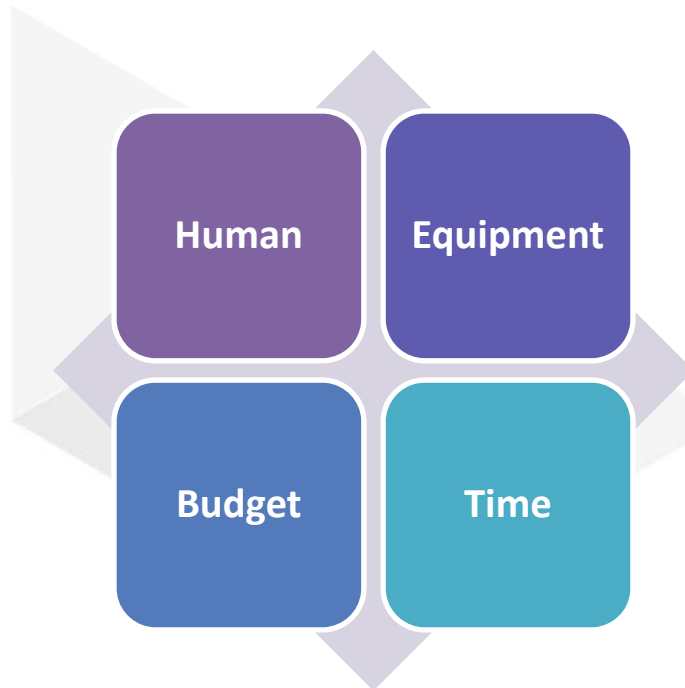
METRIC 5: RESOURCE GAPS

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RESOURCE TYPES & INDICATORS

Resource types



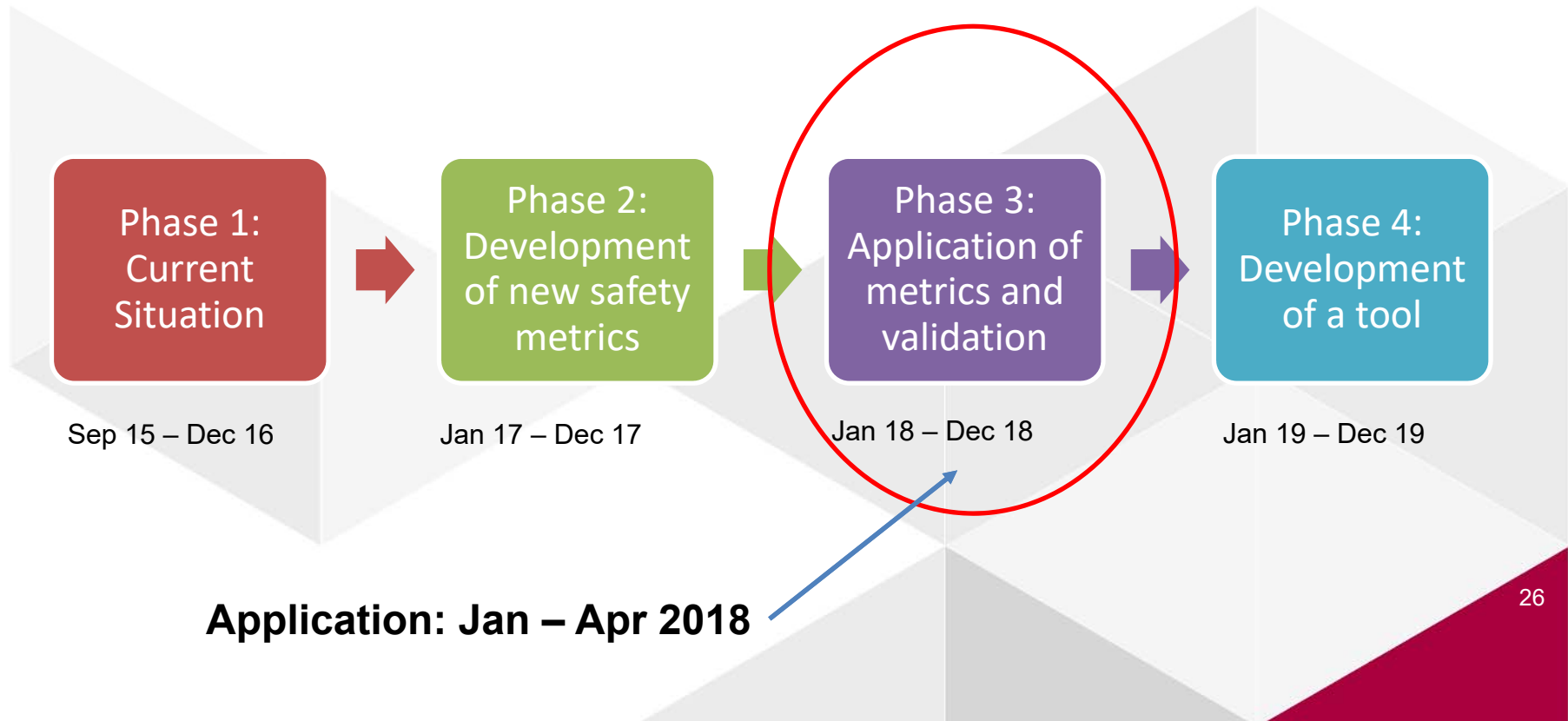
Indicators

- Available runtime/required runtime
- Available person-hours/required person-hours
- (Voluntary) staff turnover
- Budget invested/budget spent for a specific activity or a group of activities.
- Number of equipment available/number of equipment required

RESEARCH PHASE 3: APPLICATION OF METRICS



APPLICATION AND TESTING: TIMELINE



SAFETY METRICS VS SAFETY/SYSTEM OUTCOMES

Increased adverse safety outcomes will be associated with:

- Lower SMS performance scores
- Higher Safety Culture Prerequisites gaps
- Lower effectiveness of risk controls

Increased adverse system outcomes (i.e. not only safety outcomes) will be associated with:

- Higher complexity/coupling
- Lower resources availability
- Larger Wal-WaD gaps



SAFETY METRICS & OUTCOMES: WHERE/HOW TO COLLECT

- Small-Medium companies: one measurement per company
- Large companies: one measurement per relatively independent area
- SMS & SCP:
 - Deskwork: self-performed by companies
 - Surveys: offered online
- Application of other metrics on-site by the researchers



WHY JOINING US?

- **Get a better understanding of your own operations** across the five focus areas of the metrics
- **Get access to benchmarking results** against other high-performing aviation companies participating in the project
- **Become a pioneer** in introducing performance based metrics to complement compliance with aviation standards
- **Demonstrate your commitment** to safety innovation
- **Show your leading role** in improving safety proactively



APPRECIATING OUR PARTNERS

- **Acknowledgment of contribution in technical reports** and international publications and presentations
- **Upload of company logo** on the website of the research project
- **Free inhouse workshop on a selected topic** during surveys for application of metrics
- **Reduced registration fees** for the Aviation Academy events and master classes

BUT ABOVE ALL BENEFITS...

**because improving safety
is our social responsibility!**

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Questions?

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