

# COST of SMS

## The EUROCONTROL Approach & Associated S/W Tool

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The European Organisation for the Safety of Air Navigation

## What is the challenge beyond the SMS technicality?

- Have you already been requested to financially justify safety initiatives and/or your activities?
- Do you think that the possibility to provide financial figures to your management or to the Board would help the deployment and operation of Safety Management?

# Scope & Rationale of the Cost of SMS project

To assess the feasibility of the definition of a cost-model for SMS activities.

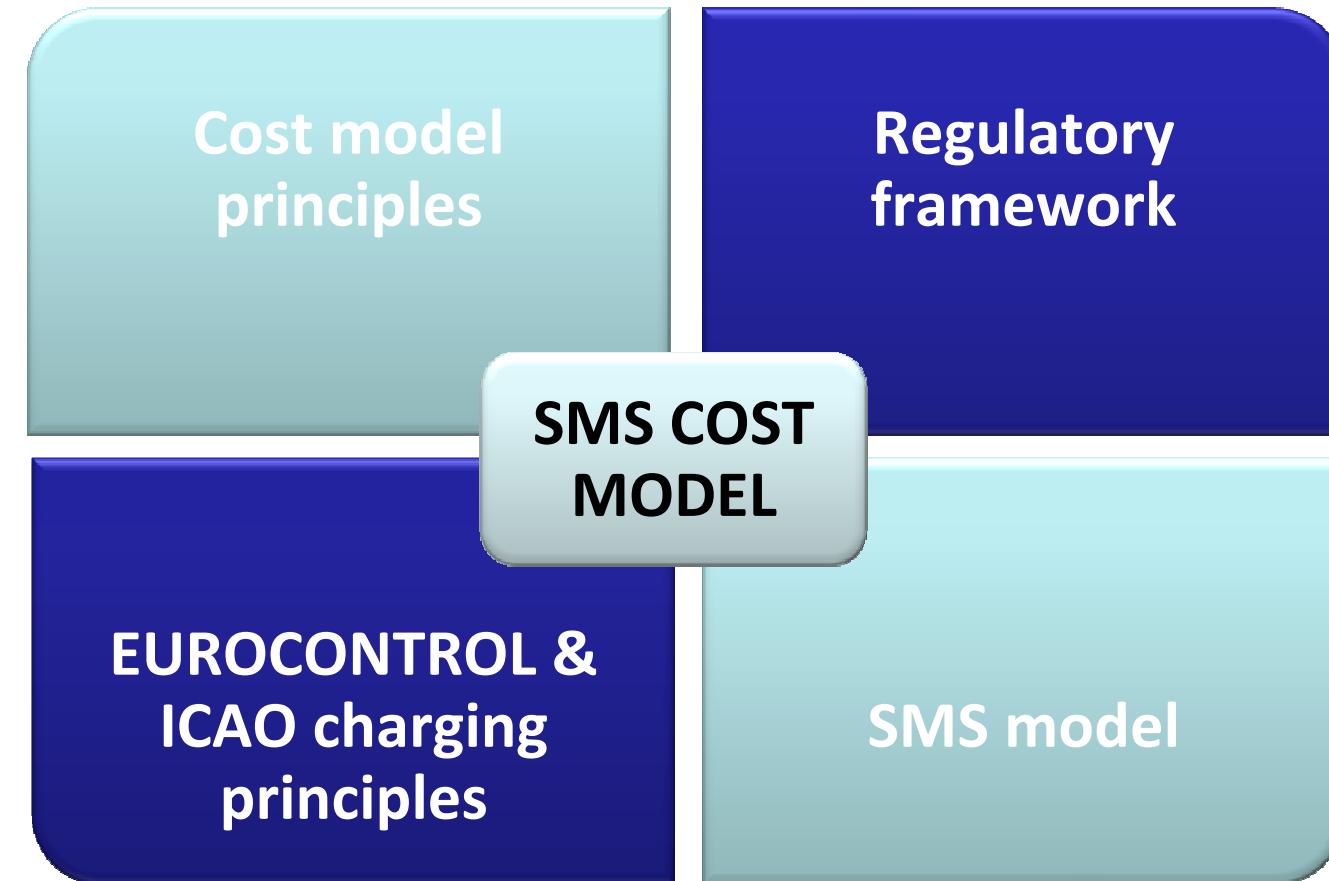
## Scope

- Development & Introduction
- Day-to-day Operations & Maintenance

## Initial Rationale

... to make a “business case” for the initiatives ANSPs/EUROCONTROL want to realize. In this context, every single recruitment and every investment needs to be substantiated by a “return of investment” analysis ....

# Approach





## Regulatory framework

- EUROCONTROL ESARRs
- Commission Regulation 2096/2005
- Directive 2006/23/EC on a Community air traffic controller licence
- Directive 2003/42/EC on occurrence reporting in civil aviation
- Directive 94/56/EC establishing the fundamental principles governing the investigation of civil aviation accidents and incidents
- Commission Regulation 1315/2007 on safety oversight in ATM
- Commission Regulation 482/2008 on software safety assurance in ATM
- Draft EASA Rules ATM001 – ATM004



## Best practices for the SMS Model

- EGSMM (EUROCONTROL Generic Safety Management Manual)
- ICAO Doc 9859 – Safety Management Manual
- ATM Safety Framework Maturity Survey – Methodology for ANSPs

# Aligned with the 2010+ ANSPs ATM Safety Framework



## Scope of SMS components/procedures

- Definitions for cost of safety management and cost of safety
- Decomposition of the safety procedures in terms of:
  - Objective
  - Input (e.g. regulatory requirements)
  - Activities (tasks)
  - Type of resources used (e.g. OPS, ENG)
  - Infrastructure & equipment
  - Training needs, and
  - Output (of SMS procedure)

# Inventory of SMS cost elements

## Eligible SMS costs

- Human effort costs
- Training costs
- Investment costs
  - (e.g. *infrastructure & equipment*)
- Non-effort costs
  - (e.g. *publications, leaflets, production cost of manuals, etc.*)



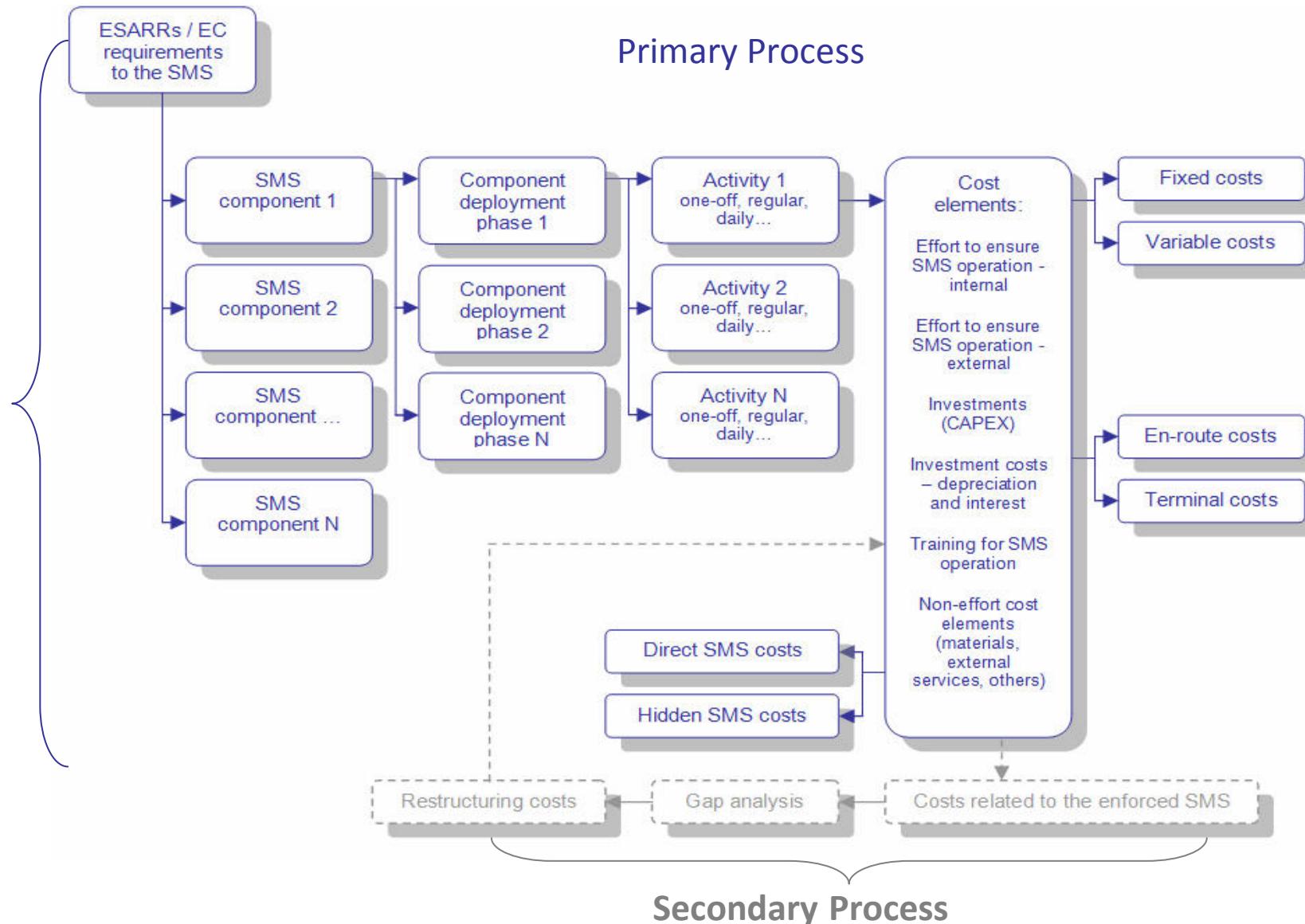
## EUROCONTROL & ICAO charging principles

- ICAO Manual of Air Navigation Services Economics, Doc. 9082 and Doc. 9161
- EUROCONTROL Principles for Establishing the Cost-Base for En-route Charges and the Calculation of the Unit Rates
- EUROCONTROL Guidance on the Rules and Procedures of the En-route Charges System
- EC Regulation 550/2004 on the provision of air navigation services in the single European sky
- EC Regulation 1794/2006 on common charging scheme for air navigation services

# Cost model principles

- Standard cost model - SCM
  - The most appropriate to measure costs in order to meet requirements and obligation imposed by regulation
- Activity based
  - Breaking down the SMS components to the level that can be measured
- Quantitative methodology
  - The model is based on a quantitative methodology to measure the resources, which are necessary to be employed by an ANSP to meet SMS requirements. Qualitative
- Management accounting systems
  - Reflecting resources expanded in order to ensure the functioning of an economic entity

# Outline model structure



## What you can do with the SMS cost model?

- Identify implementation and operation costs per SMS procedure or for whole SMS;
- What will be the cost of a new procedure;
- Different analyses of human effort distribution;
- Costs of different elements of SMS;
- Optimise costs – do you have the right resources ?
- Assess feasibility of new safety targets from perspective of resources available or budget
- Make analysis of the allocation of SMS intrinsic cost regarding the implementation strategy or operation monitoring and identify weaknesses & strengths

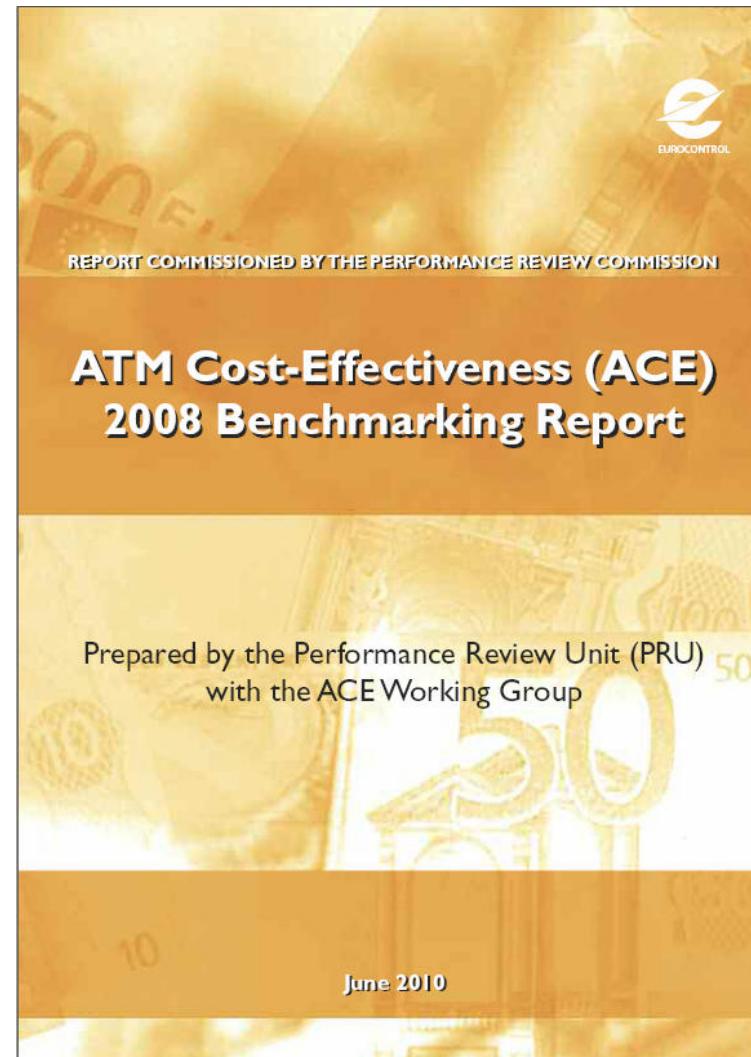


## What we Achieved

- Hands-on evaluation with several ANSPs for a reliable validation (including 1 Airline and 1 Aerodrome Operator)
  - We need to cover all SMS procedures
- Analysis of the results (on going)
- An update of the model based on the analysis & documentation
- Development of a user friendly tool to be used with the updated model;
- Training and awareness for usage
- Link with Safety Maturity Framework

# Further development

- Link with ACE
- Clarifications
- Coordination with PRU/PRC
- ...



# SMS COST MODEL

## In more details

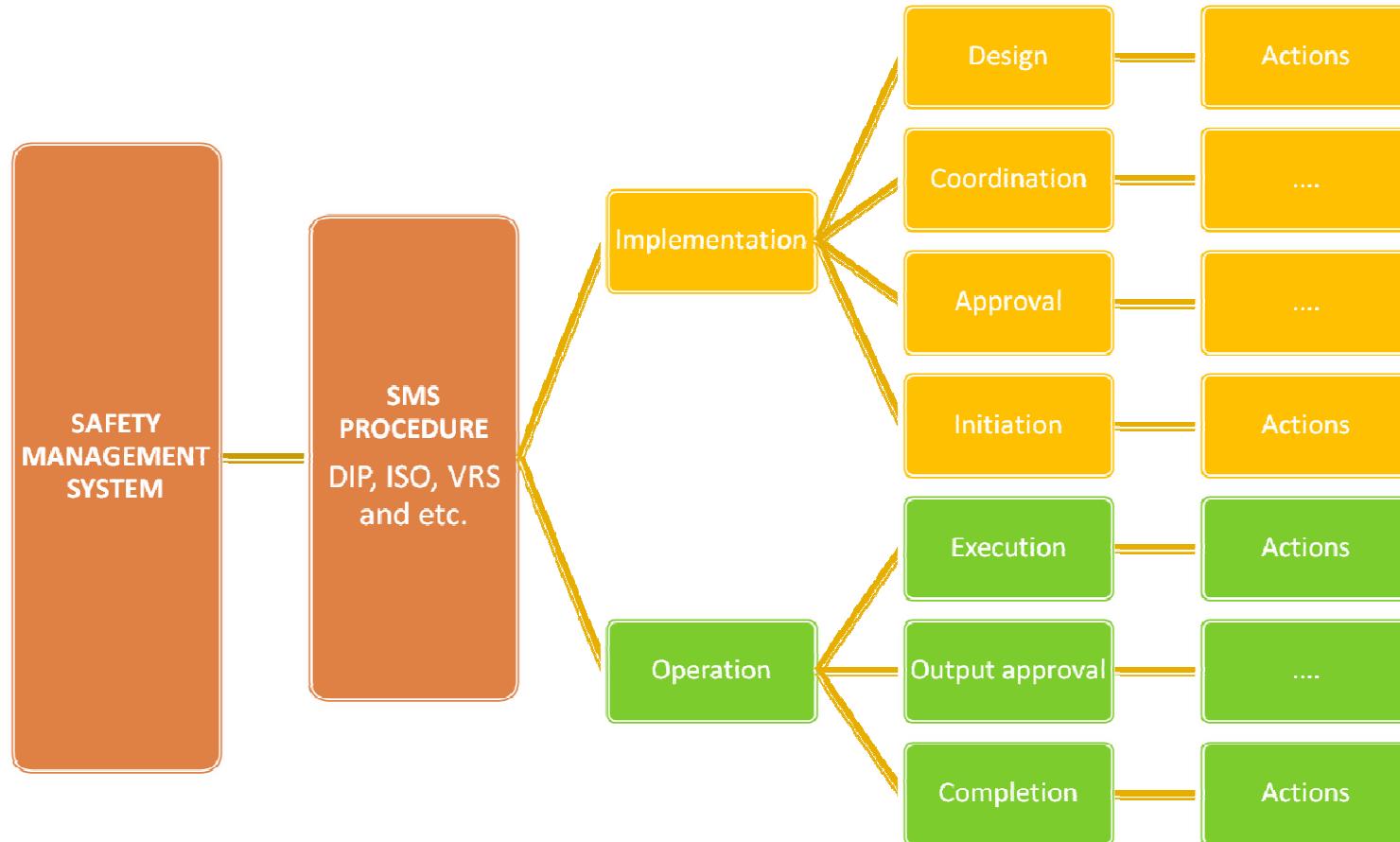
Model input

Model output

# Decomposing the problem

- Two cost cards per procedure:
  - Implementation
  - Operation
- Four cost components in each task:
  - Human effort
  - Training
  - Infrastructure and equipment
  - Non-effort elements
- Adaptation to SMS enhancement
  - SMS Baseline cost model
  - Safety Maturity categories/levels

# Overview of SMS break down



# Cost model input/output

- Model Input
  - Global variables
  - Implementation cost card
  - Operation cost card
- Model Output (results)
  - Human effort
  - Training
  - Infrastructure & equipment
  - Non-effort elements

## Global variables

- Global variables
  - Daily rates
    - SAF
    - OPS, ENG
    - MAN, ANC, ADM
    - INT & EXT Trainers or support
  - Inflation
  - Weighted average cost of capital
  - Annual effort cost increase

## Human effort - implementation

- Procedure Design
- Procedure Coordination
- Procedure Approval
- Procedure Initiation

## Human effort - operation

- Procedure Execution
- Procedure Output Approval
- Procedure Completion

# Training

- Input data
  - Training courses
  - Training infrastructure and equipment e.g. SOE (Standard office Equipment), venue
  - Training missions
  - Training non-effort elements
    - e.g. training materials
- Output
  - Total training cost

## Infrastructure and equipment

- Input data
  - Gross balance value
  - Expected operating life
  - % for SMS purposes
- Output data
  - Cost (depreciation and interest) for the whole operating life

## Non-effort elements

- Input data
  - Unit price
  - Quantity
  - Frequency per year
- Output data
  - Total cost

## Results of SMS cost modeling

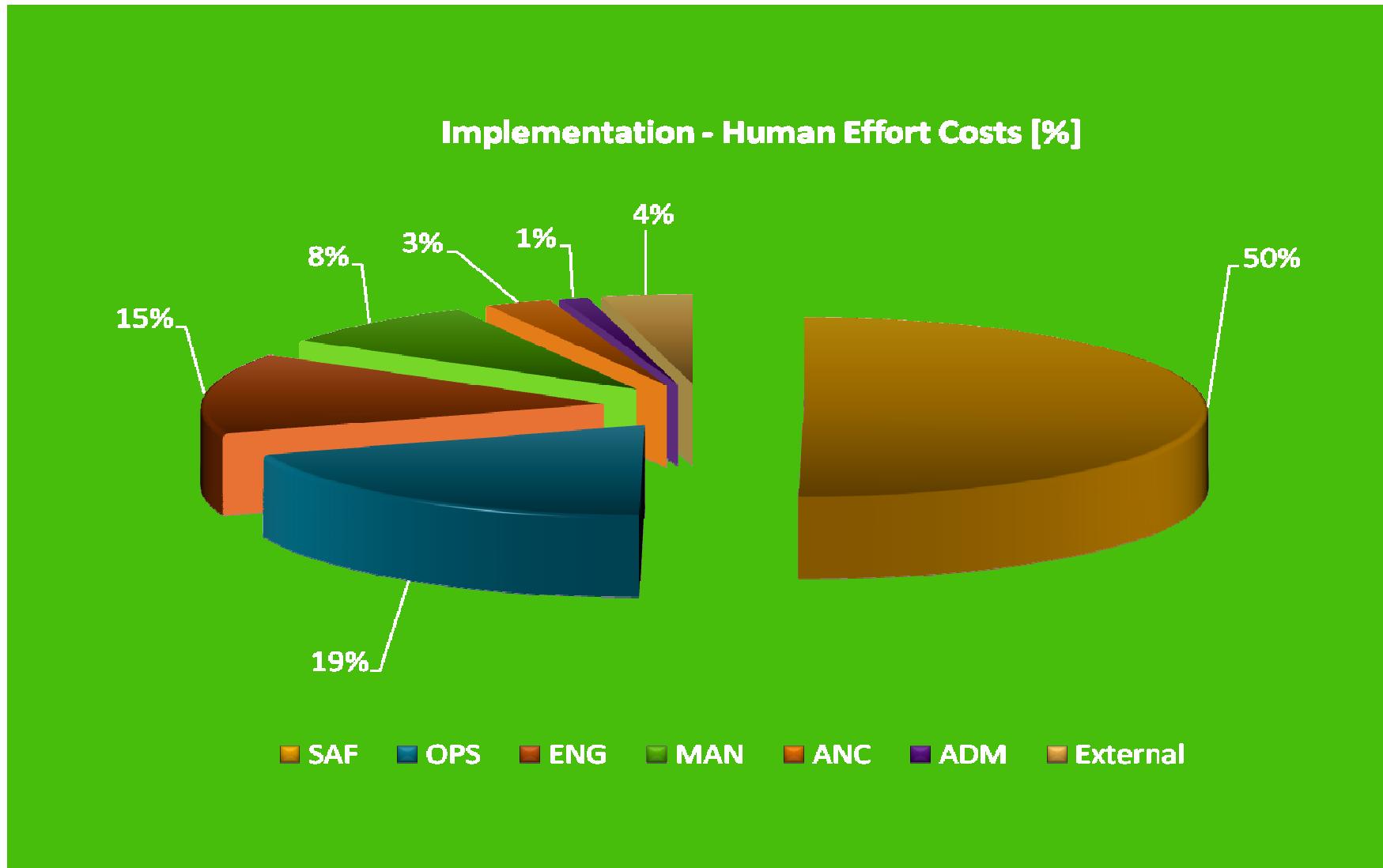
- Implementation costs
- Operation costs
- For individual procedures and overall
- Analysis of human effort distribution
- Overall cost of different SMS elements

# Graphs and reports

## Human Effort for Maintenance and day-to-day Operation of SMS

Procedure Action	Internal						External
	SAF	OPS	ENG	MAN	ANC	ADM	
	[total mandays]						
5-Execution	10.625	0.5	0.25	3	0.25	0	
6-Output approval	0	0	0	2	0	0	
7-Completion	1.5	2	2	1	1	1	
<b>Grand Total Human Effort</b>	<b>121.25</b>	<b>25.00</b>	<b>22.50</b>	<b>60.00</b>	<b>12.50</b>	<b>10.00</b>	
R-Average Rate [per day]	220 €	200 €	150 €	260 €	110 €	90 €	
OH-Overhead [%]	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	
Rate for estimations	264.00 €	240.00 €	180.00 €	312.00 €	132.00 €	108.00 €	
<b>Total Human Effort Costs</b>	<b>32 010 €</b>	<b>6 000 €</b>	<b>4 050 €</b>	<b>18 720 €</b>	<b>1 650 €</b>	<b>1 080 €</b>	<b>0 €</b>

## Graphs and reports



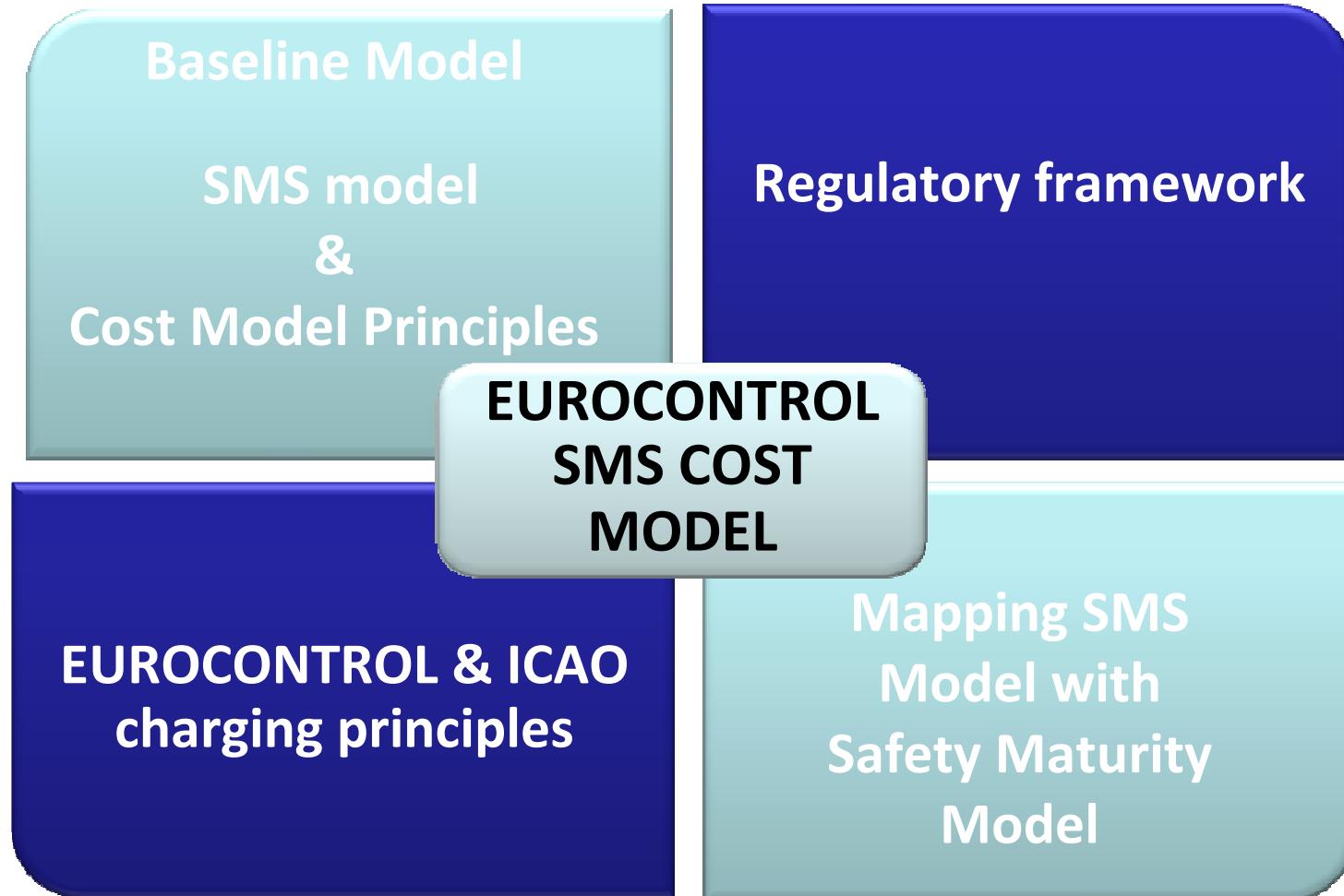
## Managing expenses in a financial crisis

- Planning manpower
- Strategic planning
- Estimating cost of individual SMS activities
- Optimizing SMS procedures
- Optimizing resources
- Assess the feasibility to meet the safety targets

## Answering questions

- How much costs me each particular activity?
- May I optimise SMS procedure in terms of effort/cost?
- May I plan manpower for my SMS? Would I meet the safety targets ?
- Can I make a plan for some years ahead?

# Link with Safety Maturity Model - Approach



## Link with Safety Maturity Model - Scope & Rationale

To start from the cost-model for SMS tasks/ activities and assess the feasibility of enhancing practices in safety management based on SMS maturity Study Area

### Scope

- Comply with Regulatory Framework
- Adopt Best Practices that are part of the Reg. Framework and taken from other ANSPs/Industries/ECTL
- Be Best Practices owner & Confident Adopter – issuing new standards for the community

### Initial Rationale

... to not replace and not assess the safety maturity model. In this context, to link the cost of SMS model with a continuous safety improvement loop....

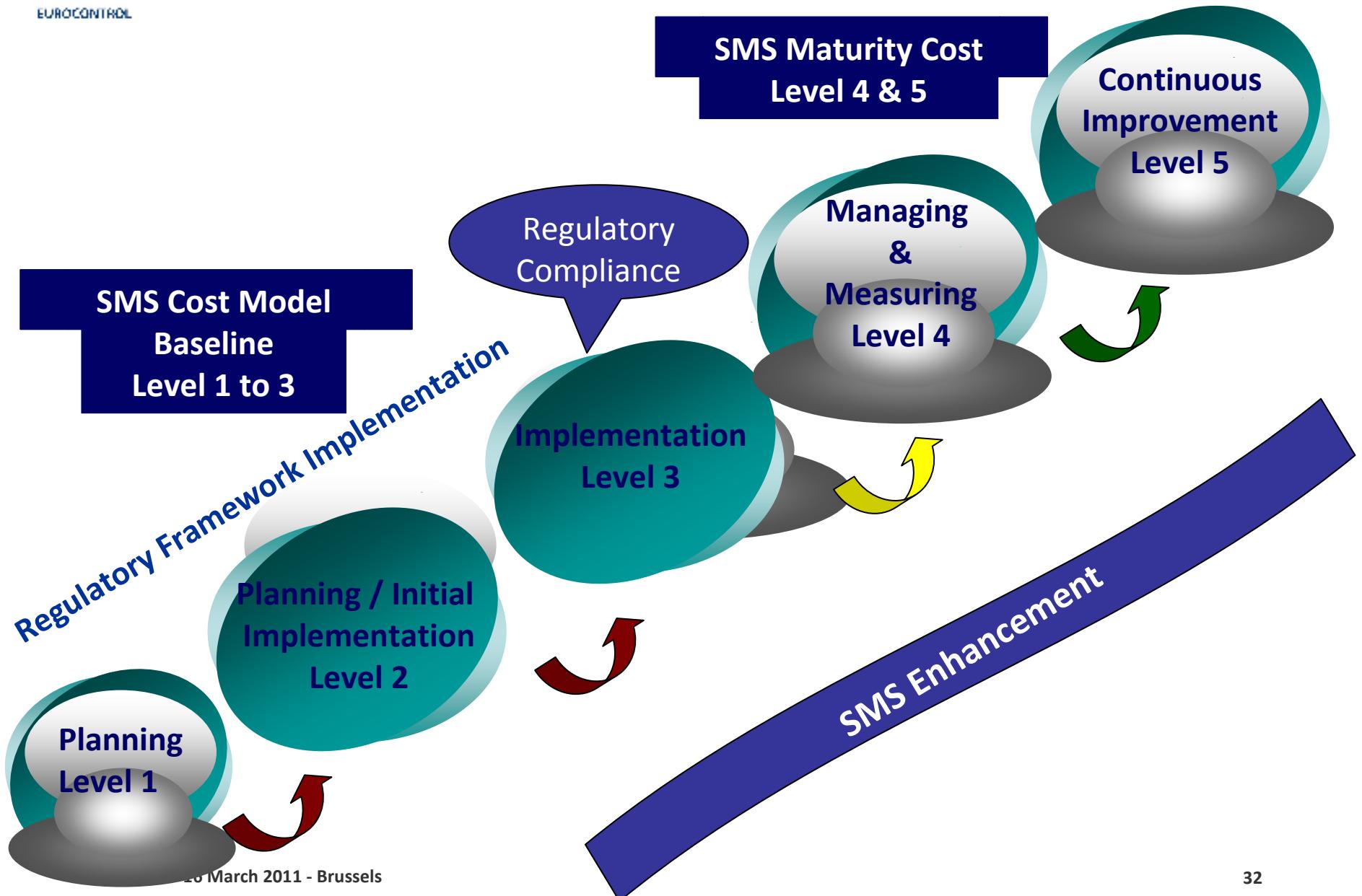
# Safety Maturity categories



All requirements for the previous stage/level must be fully satisfied before proceeding to the next stage of the model. No maturity stages can be missed.

<b>Initiating</b>	<b>Planning/Initial Implementation</b>	<b>Implementing</b>	<b>Managing and Measuring</b>	<b>Optimising</b>
<ul style="list-style-type: none"> <li>• Awareness exists of the need for SMS. No specific formal implementation actions are in place or planned.</li> <li>• The processes for managing safety are ad-hoc and/or inconsistent with the Organisation's safety obligations.</li> </ul>	<ul style="list-style-type: none"> <li>• A gap analysis has been performed.</li> <li>• The Organisation has an SMS Implementation Plan that is consistent with the organisation's safety goals and obligations.</li> <li>• Implementation is underway but not yet completed in some major aspects.</li> </ul>	<ul style="list-style-type: none"> <li>• The Organisation has achieved the required regulatory standard.</li> <li>• The SMS standard processes are in use across the organisation and are producing consistent results. The results are being measured using qualitative techniques.</li> </ul>	<ul style="list-style-type: none"> <li>• SMS Implementation has been completed and both safety performance and system performance are measured and controlled using statistical and other quantitative techniques.</li> <li>• Quantitative safety objectives are based on customer, end user and organisational needs.</li> <li>• Sub-processes are developed that significantly contribute to overall organisation safety performance.</li> </ul>	<ul style="list-style-type: none"> <li>• Safety processes/ systems are firmly embedded within the organisation.</li> <li>• The focus is on continuous improvement in operational safety and maximising the effectiveness of SMS processes through innovative improvements.</li> <li>• There are defined processes to set standards and improvement targets.</li> <li>• The effectiveness of the SMS and safety improvement actions are measured and evaluated against defined improvements criteria.</li> </ul>
<i>The SMS components and elements are not documented and have not been implemented. No SMS Implementation Plan has been developed.</i>	<i>An Implementation Plan exists covering all SMS. The plan is not yet fully deployed. SMS components and elements are not yet effective and do not yet meet the required regulatory standard.</i>	<i>The SMS Implementation Plan is mostly implemented. SMS components and elements meet the required regulatory standard.</i>	<i>The SMS is fully implemented and its components and elements are effective. The Organisation is identifying / adopting Industry best practices beyond the regulatory compliance requirements.</i>	<i>The SMS processes are continually improved to meet the needs of the organisation and are producing a demonstrable improvement in safety performance. The Organisation is setting the Industry SMS best practices.</i>
<b><i>The organisation is not measuring and monitoring safety performance.</i></b>	<b><i>The organisation has a plan to capture information about safety performance.</i></b>	<b><i>The organisation is collecting safety reports under a controlled process, and is responding to safety issues identified as a result of individual incident investigations.</i></b>	<b><i>The organisation is measuring safety performance. It has identified its key safety risks and has developed plans for improvement.</i></b>	<b><i>The organisation is managing its key safety risks in conjunction with external stakeholders and can demonstrate improved safety performance.</i></b>

# The EUROCONTROL SMS Cost Model



# SMS Procedures & Safety Framework Maturity Study Areas

1	SMS development & implementation plan
2	Organisation's safety policy
3	Safety targets and safety indicators
4	SMS organisational structure
5	Safety responsibilities & accountabilities
6	SMS documentation
7	Competency assurance
8	Safety of external services
9	Mandatory reporting system
10	Voluntary reporting system
11	Investigation of safety occurrences
12	Management of safety-related changes
13	Risk assessment and mitigation
14	Software safety assurance system
15	Safety surveys
16	Safety monitoring
17	Safety records
18	Safety improvement
19	Lesson dissemination & safety awareness

## **Safety Culture**

SA1 Development of a positive and proactive safety culture

## **Safety Policy**

SA2 Organisational and Individual Safety Responsibilities

SA3 Timely Compliance with International Obligations

## **Safety Achievement**

SA4 Safety standards and procedures

SA5 Competency

SA6 Risk Management

SA7 Safety Interfaces

## **Safety Assurance**

SA8 Safety Reporting, Investigation and Improvement

SA9 Safety Performance Monitoring

SA10 Operational Safety Surveys and SMS Audits

## **Safety Promotion**

SA11 Adoption and Sharing of Best Practices

# Mapping of SMS cost model to SMS maturity model



No	Elements	SMS maturity model										
		SA 1	SA 2	SA 3	SA 4	SA 5	SA 6	SA 7	SA 8	SA 9	SA 10	SA 11
1	SMS development & implementation plan	x	x	x								
2	Organisation's safety policy		x	x								
3	Safety targets and safety indicators		x	x						x		
4	SMS organisational structure		x	x								
5	Safety responsibilities & accountabilities		x	x								
6	SMS documentation			x	x							
7	Competency assurance			x		x						
8	Safety of external services			x					x			
9	Mandatory reporting system			x						x		
10	Voluntary reporting system									x		
11	Investigation of safety occurrences			x						x		
12	Management of safety-related changes			x	x							
13	Risk assessment and mitigation			x				x				
14	Software safety assurance system			x				x				
15	Safety surveys			x							x	
16	Safety monitoring			x					x	x		
17	Safety records			x					x			
18	Safety improvement			x	x		x				x	
19	Lesson dissemination & safety awareness			x					x			x

# Mapping of Type 1 discrepancies (gaps) to the SMS maturity model



	<b>SMS cost model</b>	<b>SMS maturity model</b>										
No	Gaps	SA 1	SA 2	SA 3	SA 4	SA 5	SA 6	SA7	SA8	SA 9	SA 10	SA 11
1	Development of a positive & proactive safety culture	x										
2	Integrated safety planning process/corporate safety plan		x									
3	Organisational change management		x									
4	Compliance with regional/international safety standards			x								
5	Emergency response procedures and planning				x							
6	Provision of feedback to the training organisations					x						
7	Management of internal interfaces							x				
8	Management of external interfaces, except services							x				
9	Safety information disclosure							x	x			
10	External safety surveys & SMS audits									x		
11	Systematic gathering of safety and SMS best practices										x	

# Three Options for the Safety Maturity Cost

Mapping SMS  
Baseline Model  
with  
Safety Maturity  
Model

Safety Maturity  
Tasks

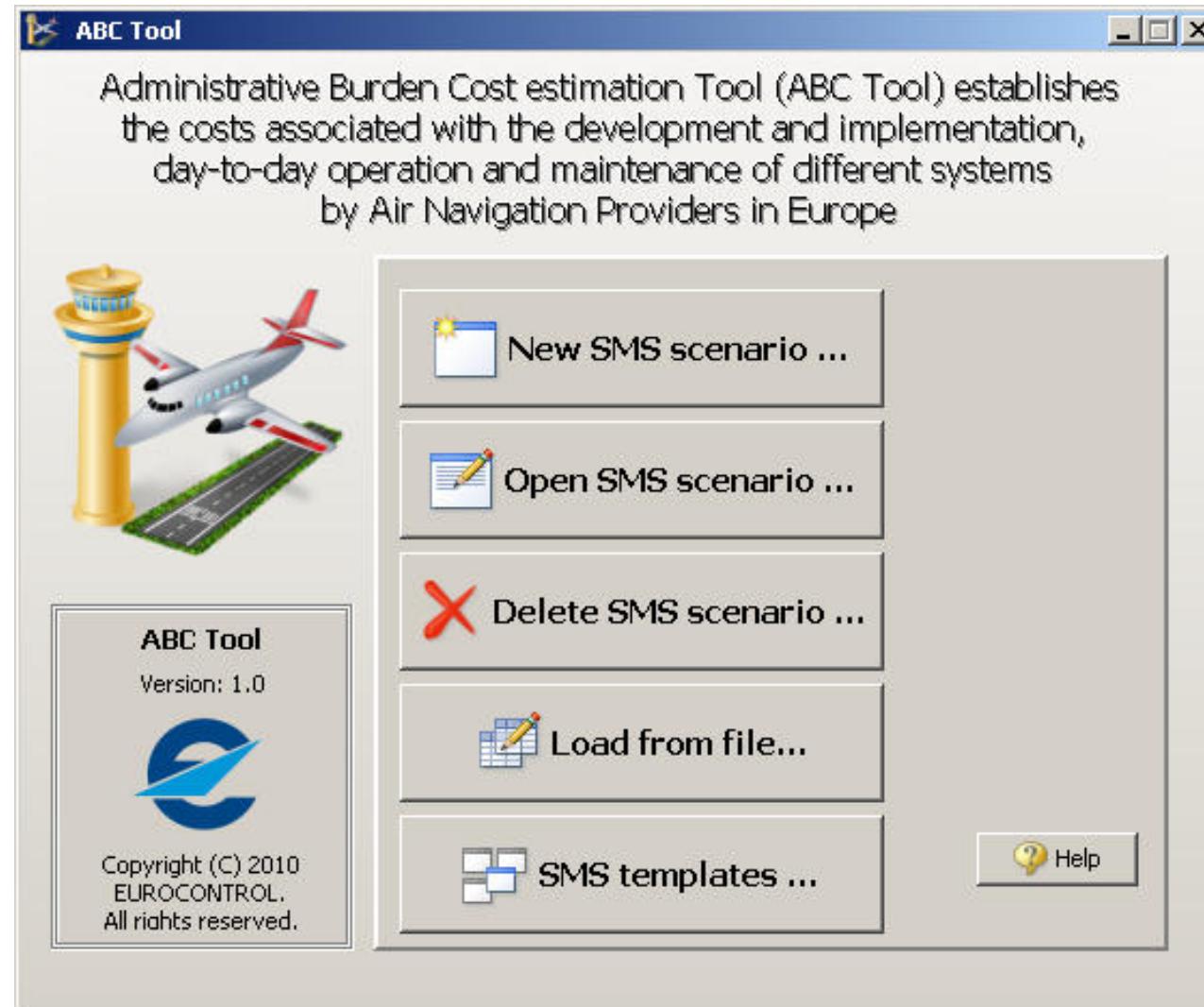
**EUROCONTROL  
SMS MATURITY  
COST MODEL**

Safety Maturity Tasks  
Unique  
Simplified

Safety Maturity Tasks  
Unique

SMS  
COST  
MODEL  
Demonstration

# The EUROCONTROL ABC Tool



# Demo – Global variables

Daily Rates			SMS cost model - Human effort assignment matrix					
Role	Rate	Overhead Rate	SAF	OPS	ENG	MAN	ANC	ADM
[safety]	[operations]	[engineering]	[management]	[ancillary]	[administration]			
SAF - daily rate	220.00 €	20.00%	Expert	Expert	Expert CNS	Top management (incl. directors)	MET	Procurement
OPS- daily rate	200.00 €	20.00%	Specialist	ATCO in OPS	COM	Line management	AIS	Accounting
ENG - daily rate	150.00 €	20.00%		ATFM/ASM	NAV		SAR	HR
MAN - daily rate	260.00 €	20.00%		Assistant	SUR		Instructor	
ANC - daily rate	110.00 €	20.00%		OPS support (non-ATCOs)	IT			
ADM - daily rate	90.00 €	20.00%		Trainee	Electro			
Internal Trainer - daily rate	220.00 €	20.00%		Instructor	Instructor			
External Trainer- daily rate	500.00 €	N/A						
External Human Effort - daily rate	300.00 €	N/A						

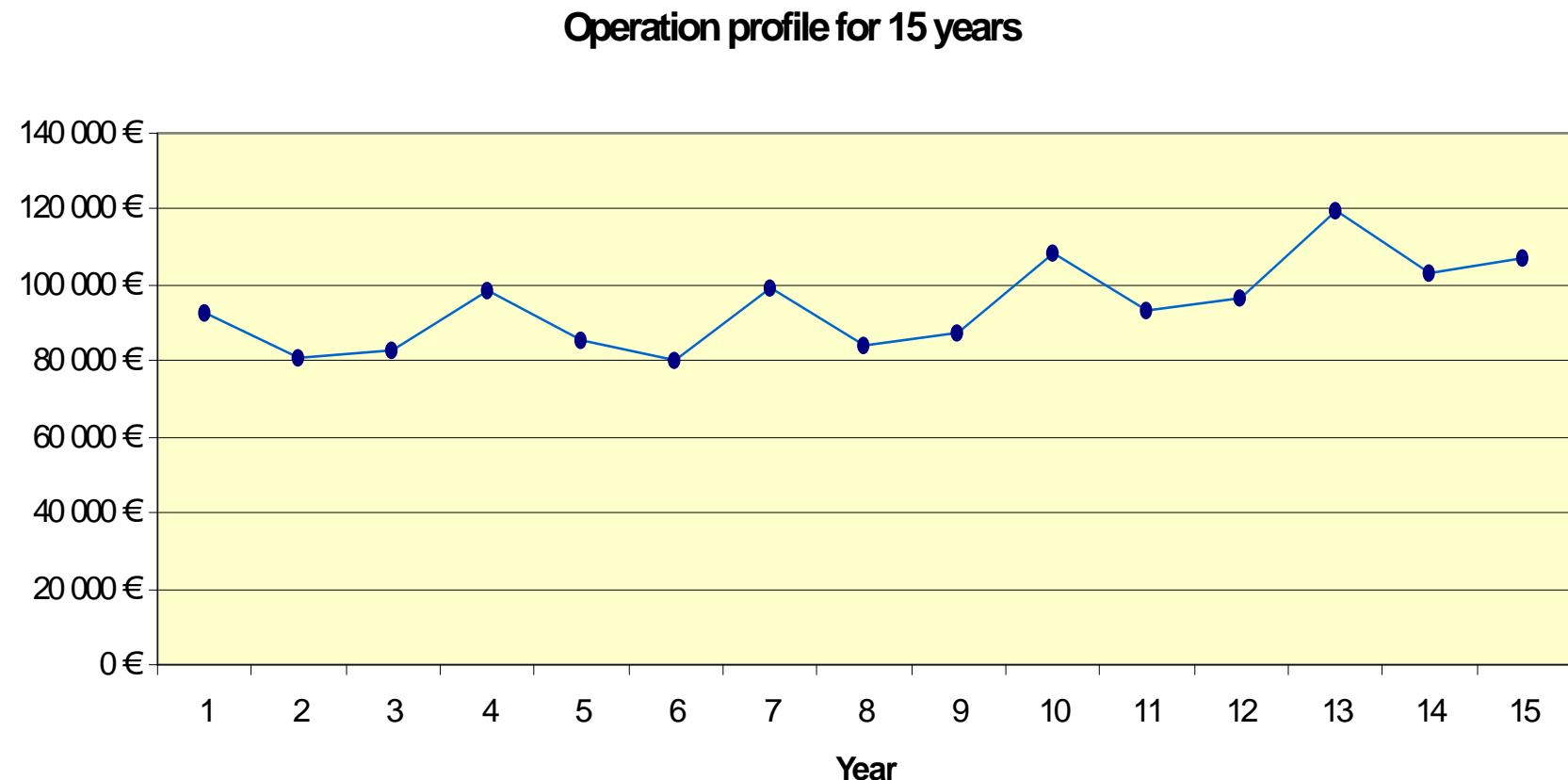
  

Global Variables	
Variable	Value
Annual effort cost increase	3.50%
Inflation	3.00%
WACC - weighted average cost of capital	5.00%

## Questions & Answers Part 1

- What is the operation profile in some years?
- What is the total man effort per annum? How is this effort distributed?
- What are direct/hidden costs?

## Operation profile - Example



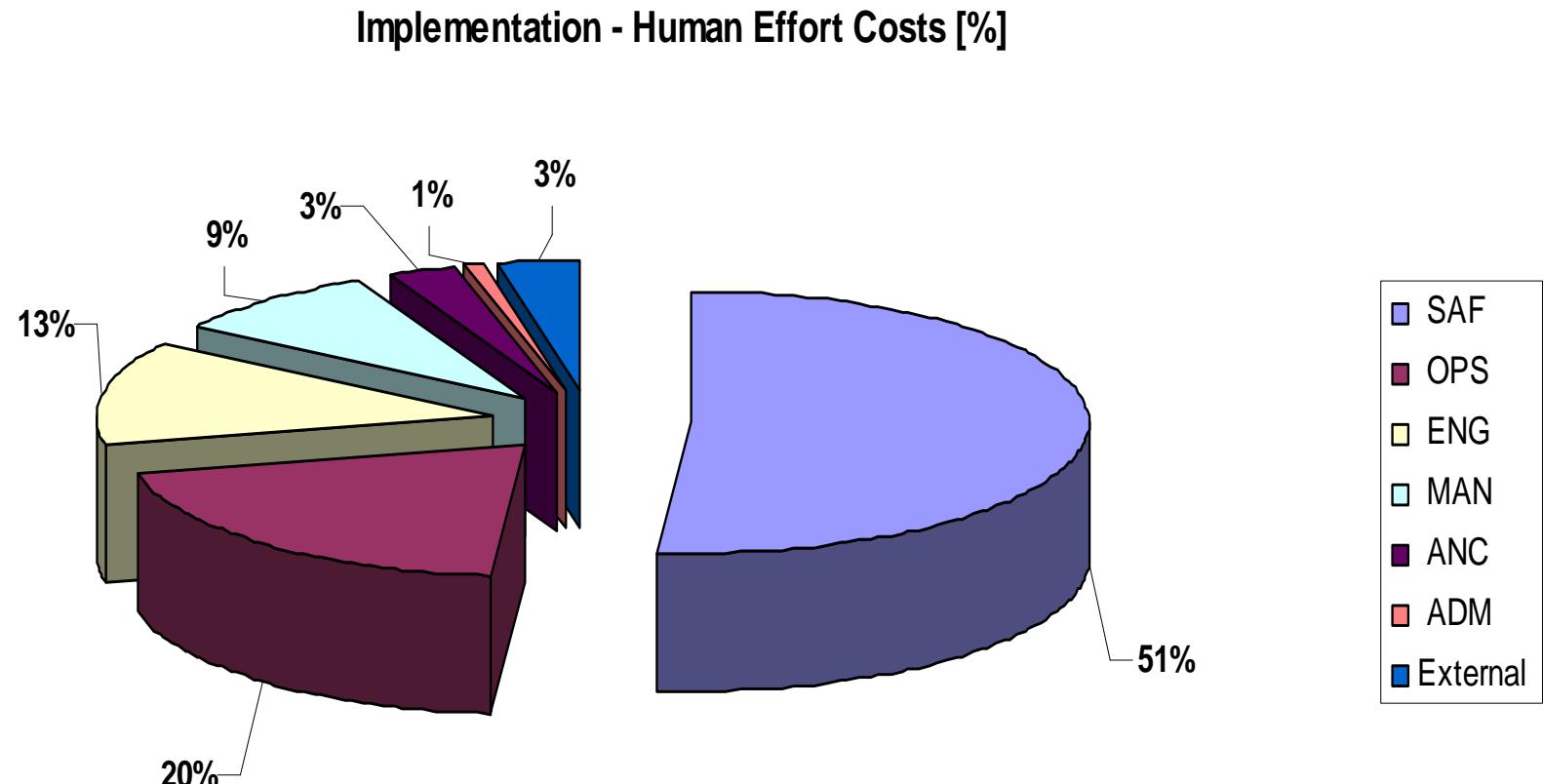
# Man effort per implementation

Human Effort for Development and Implementation of SMS							
Procedure Action	Internal						External
	SAF	OPS	ENG	MAN	ANC	ADM	
	[total mandays]	[total mandays]	[totalmandays]	[total mandays]	[total mandays]	[total mandays]	[total amount]
1-Design	41	0	0	0	0	0	
2-Coordination	12	20	20	0	0	0	
3-Approval	2	0	0	1.25	0	0	
4-Initiation	39	20	20	12	10	5	
<i>Grand Total Human Effort</i>	94	40	40	13.25	10	5	
R-Average Rate [per day]	220 €	200 €	150 €	260 €	110 €	90 €	
OH-Overhead [%]	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	
<i>Rate for estimations</i>	264.00 €	240.00 €	180.00 €	312.00 €	132.00 €	108.00 €	
Total Human Effort Costs	24 816 €	9 600 €	7 200 €	4 134 €	1 320 €	540 €	1 800 €

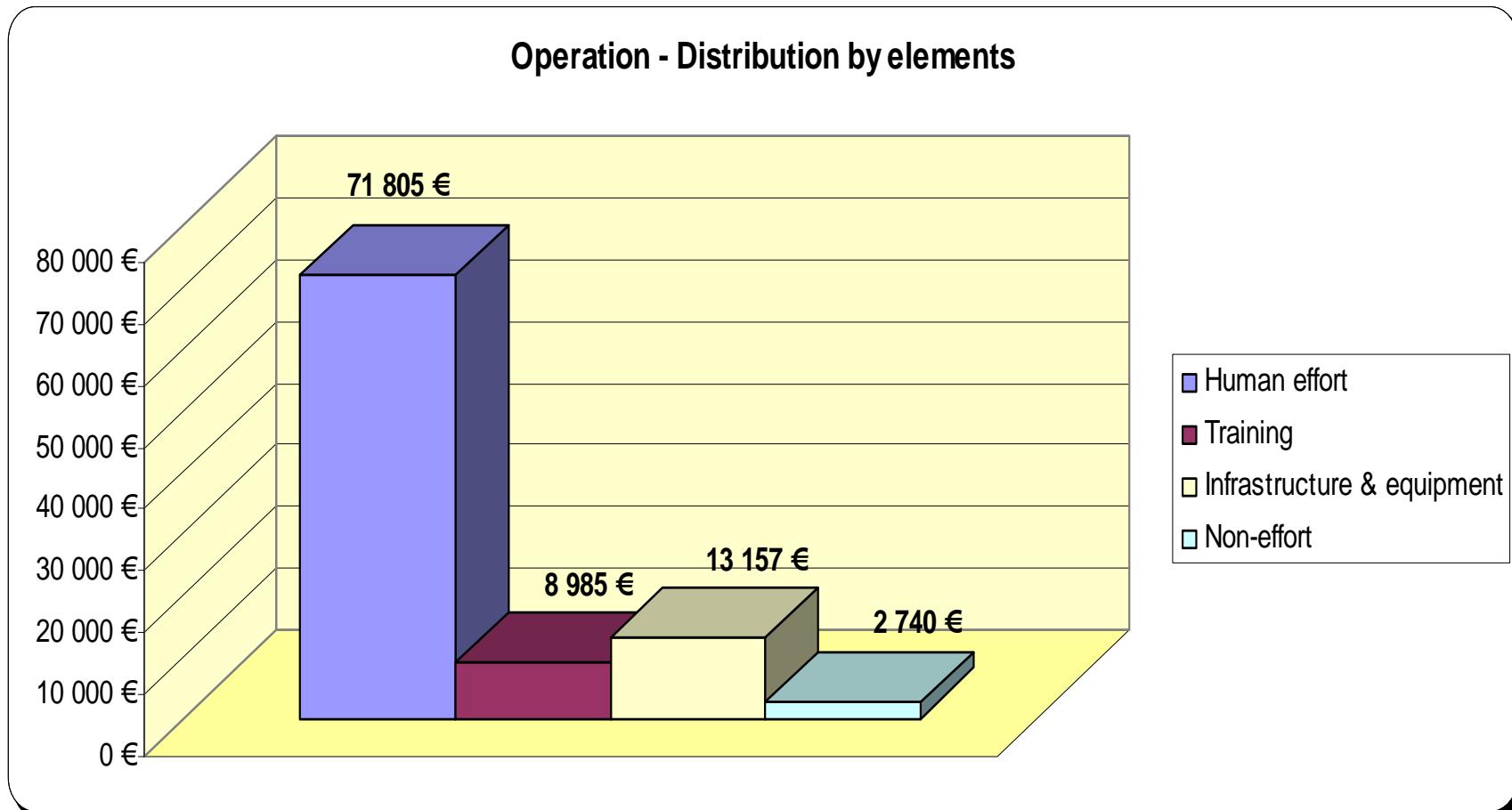
# Man effort for day-to-day operation

Human Effort for Maintenance and day-to-day Operation of SMS							
Procedure Action	Internal						External
	SAF	OPS	ENG	MAN	ANC	ADM	
	[total mandays]	[total amount]					
5-Execution	10.625	0.5	0.25	3	0.25	0	
6-Output approval	0	0	0	2	0	0	
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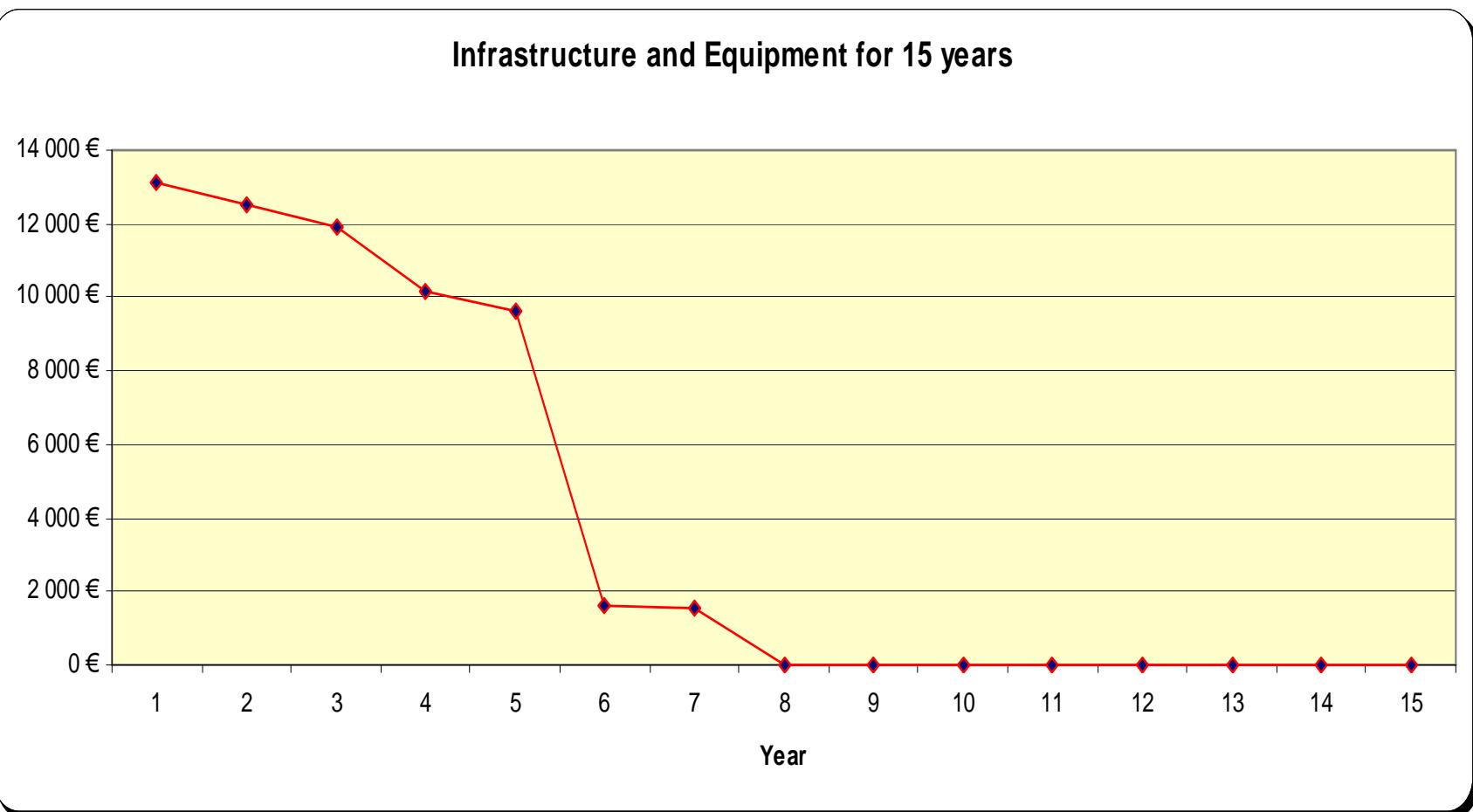
# Human effort distribution - Example



# Distribution by elements - Example



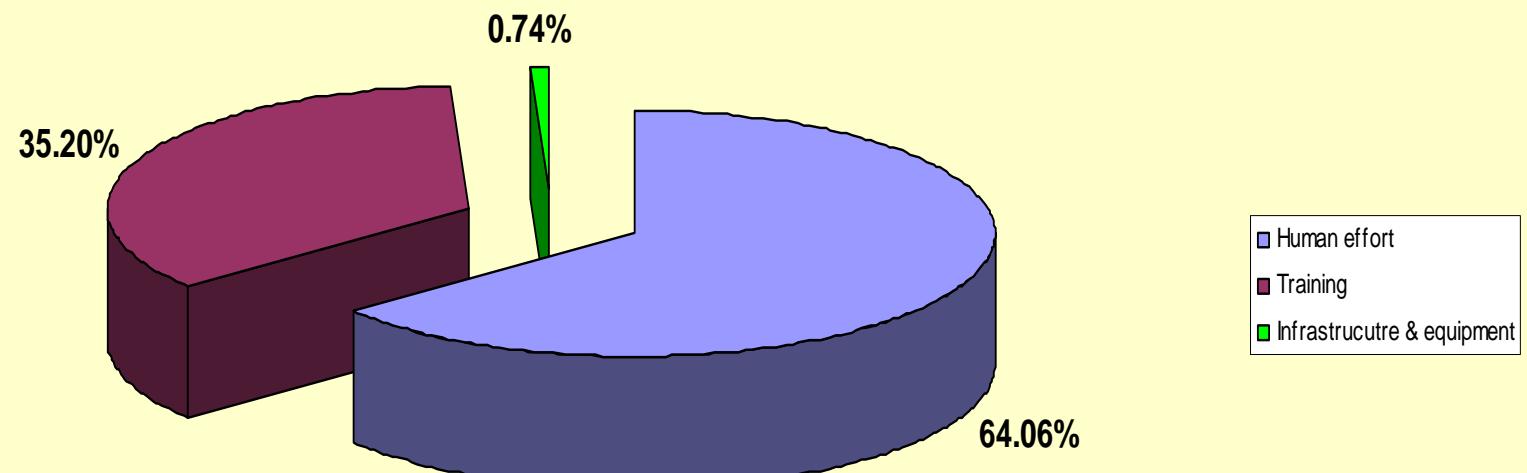
## Equipment profile - Example



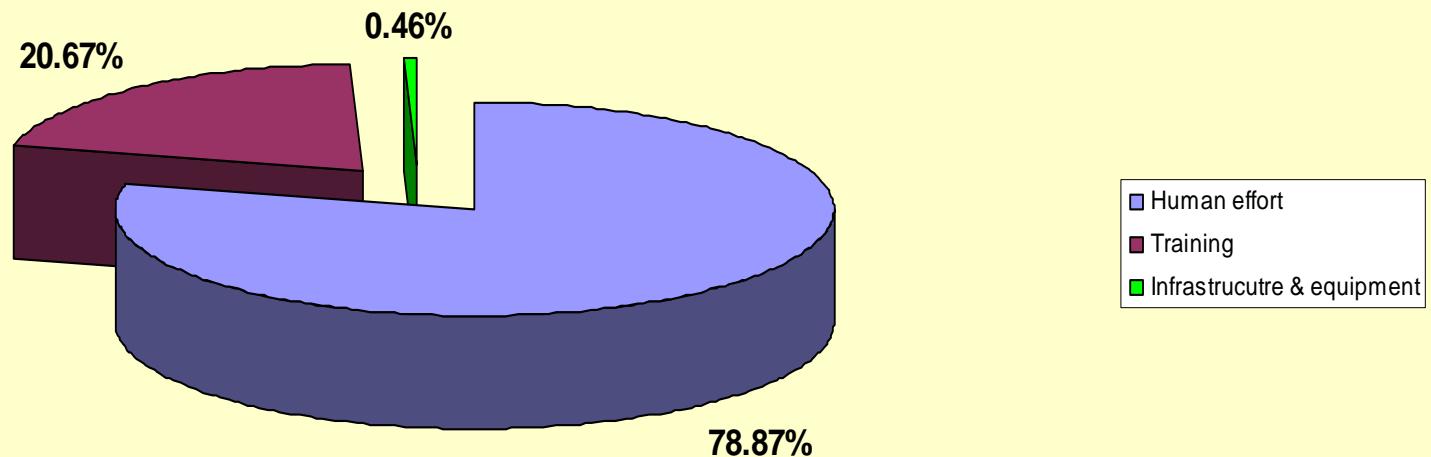
## Questions & Answers – Part II

- How much does cost the development of my SMS?
- How much does it cost me per year to run the SMS?
- What are the costs of the different SMS components?

# SMS Implementation Costs



## SMS Operation Costs



## Questions & Answers – Part III

- What is the effort spent by the different entities (units) for developing/operating SMS?
- How much will it cost me to develop, implement and run a new procedure?
- How much will it cost me to reach the new safety target/adopt best practices/apply my own approach to enhance safety

## Share by staff category

- What is the effort spent by the different entities for developing the SMS?

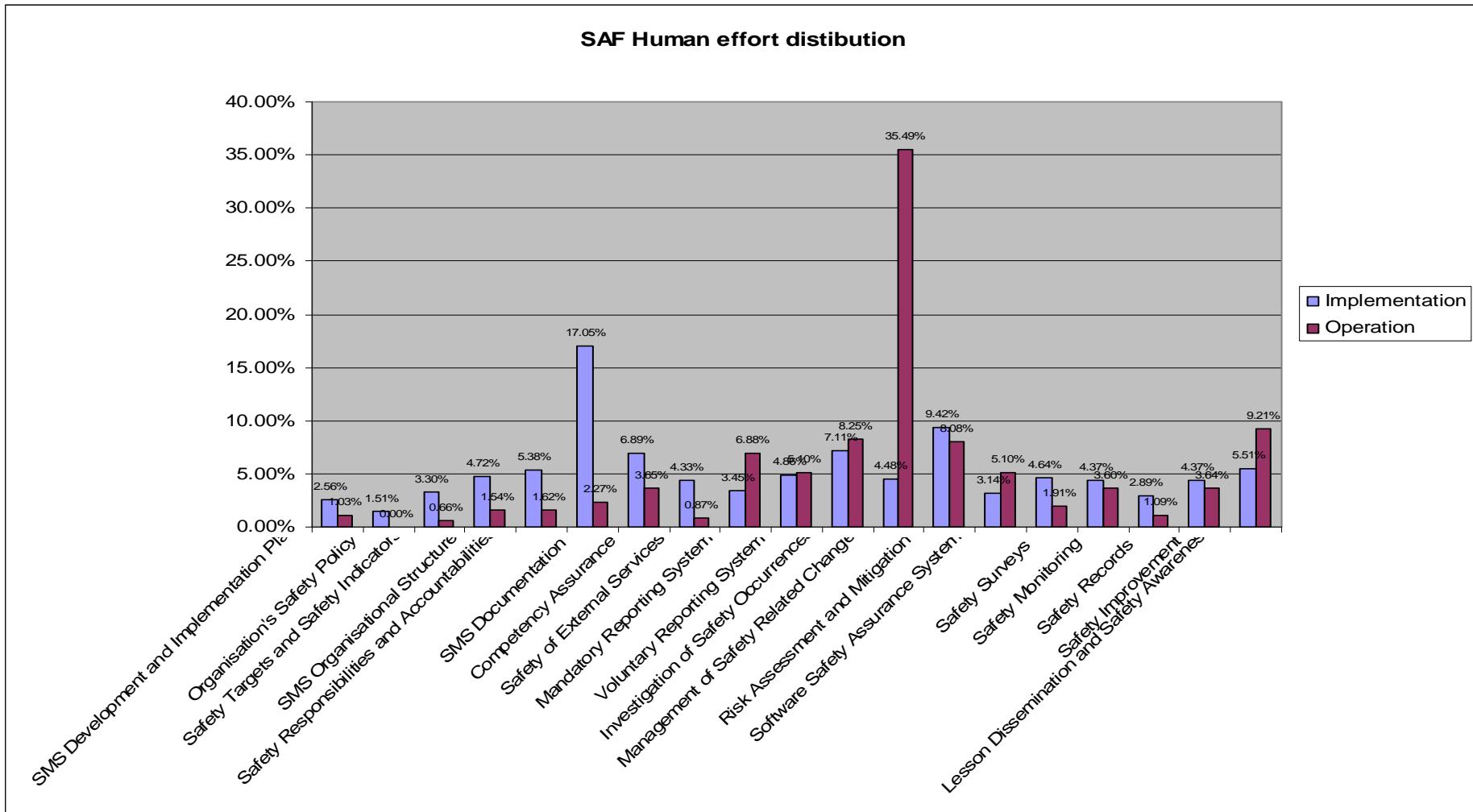
SAF	OPS	ENG	MAN	ANC	ADM	Ext
47 %	17 %	17 %	7 %	5 %	3 %	5 %

## Share by staff category

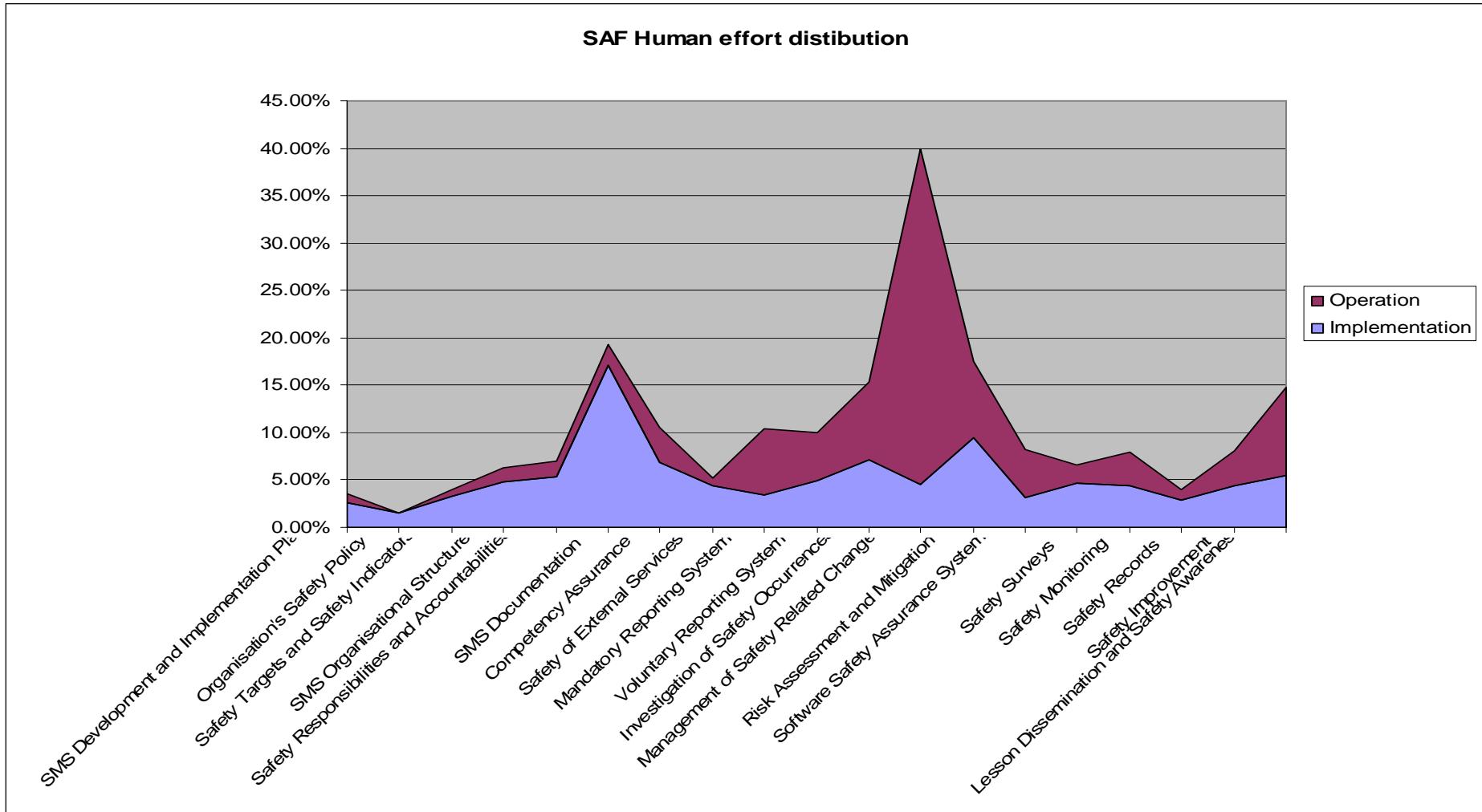
- What are the efforts spent by the different entities for operating of SMS?

SAF	OPS	ENG	MAN	ANC	ADM	Ext
43 %	18 %	18 %	13 %	5 %	1 %	1%

# SAF Human effort



# SAF Human effort



## One procedure

### Implementation Procedure:

#### Investigation of Safety Occurrences

#### Human effort man-days: (EXT - 6)

SAF	OPS	ENG	MAN	ANC	ADM
95	26	25	3.5	2.3	0.1

#### Training man-days:

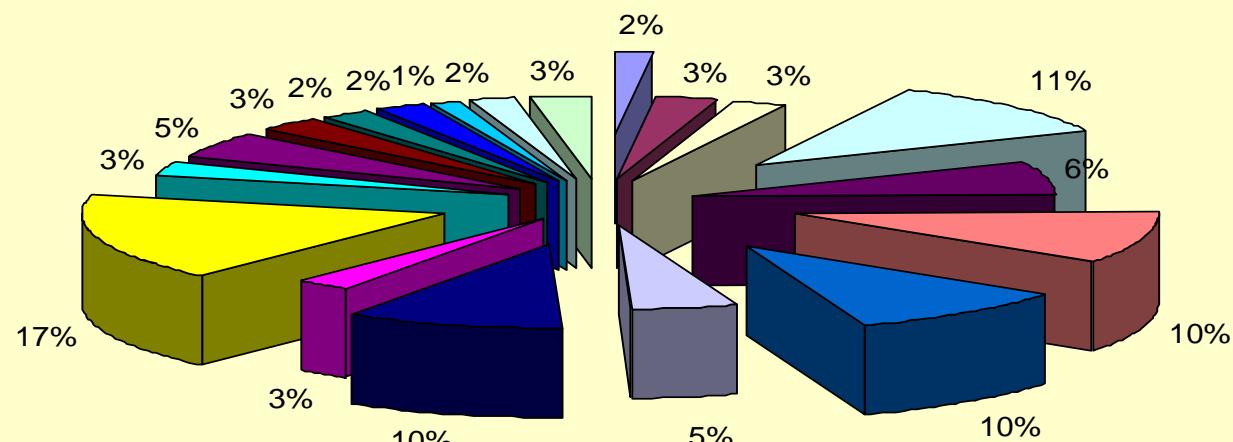
SAF	OPS	ENG	MAN	ANC	ADM
132	290	4	0	0	0

#### Infrastructure & equipment:

**Standard Office Equipment – 45 000 EUR**

# Implementation

Implementation costs [%]



- SMS Development and Implementation Plan
- Organisation's Safety Policy
- Safety Targets and Safety Indicators
- SMS Organisational Structure
- Safety Responsibilities and Accountabilities
- SMS Documentation
- Competency Assurance
- Safety of External Services
- Mandatory Reporting System
- Voluntary Reporting System
- Investigation of Safety Occurrences
- Management of Safety Related Changes
- Risk Assessment and Mitigation
- Software Safety Assurance System
- Safety Surveys
- Safety Monitoring
- Safety Records
- Safety Improvement
- Lesson Dissemination and Safety Awareness

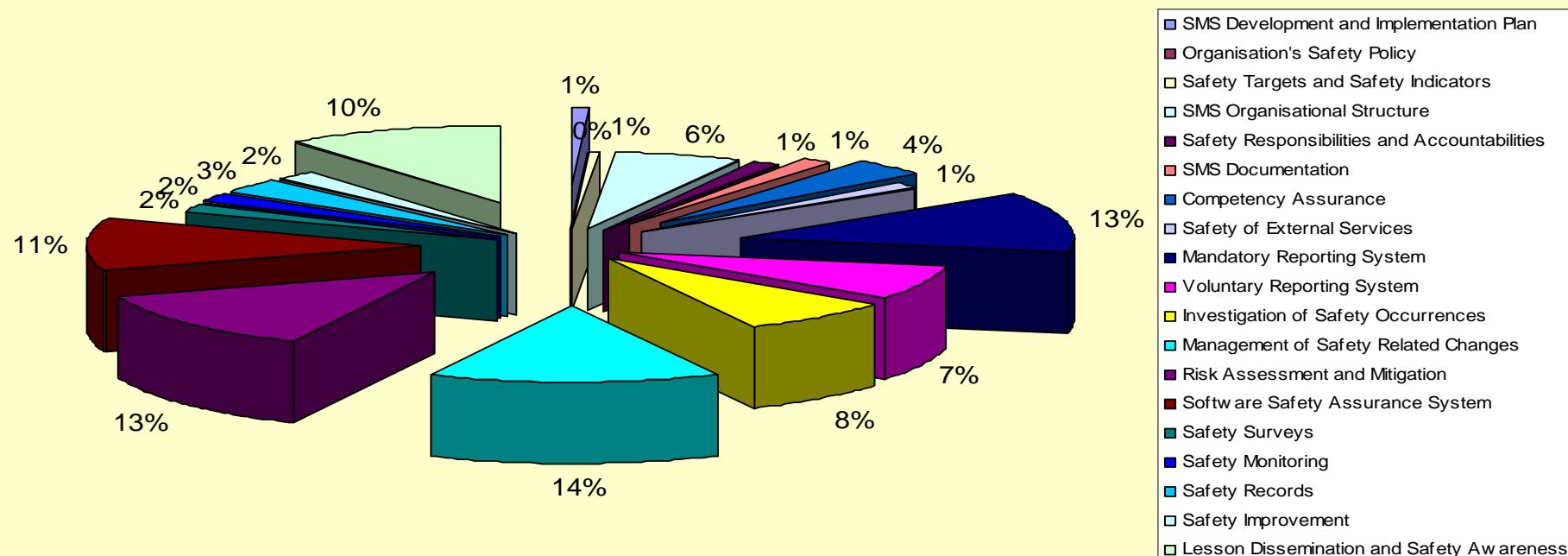
## Implementation overall costs

- SMS organisational structure – 11 %
- SMS Documentation – 10 %
- Competency assurance – 10 %
- Mandatory reporting system – 10 %
- Investigation of safety occurrences – 17 %

Five procedures make up 58 %.

# Operation costs

Operational costs [%]

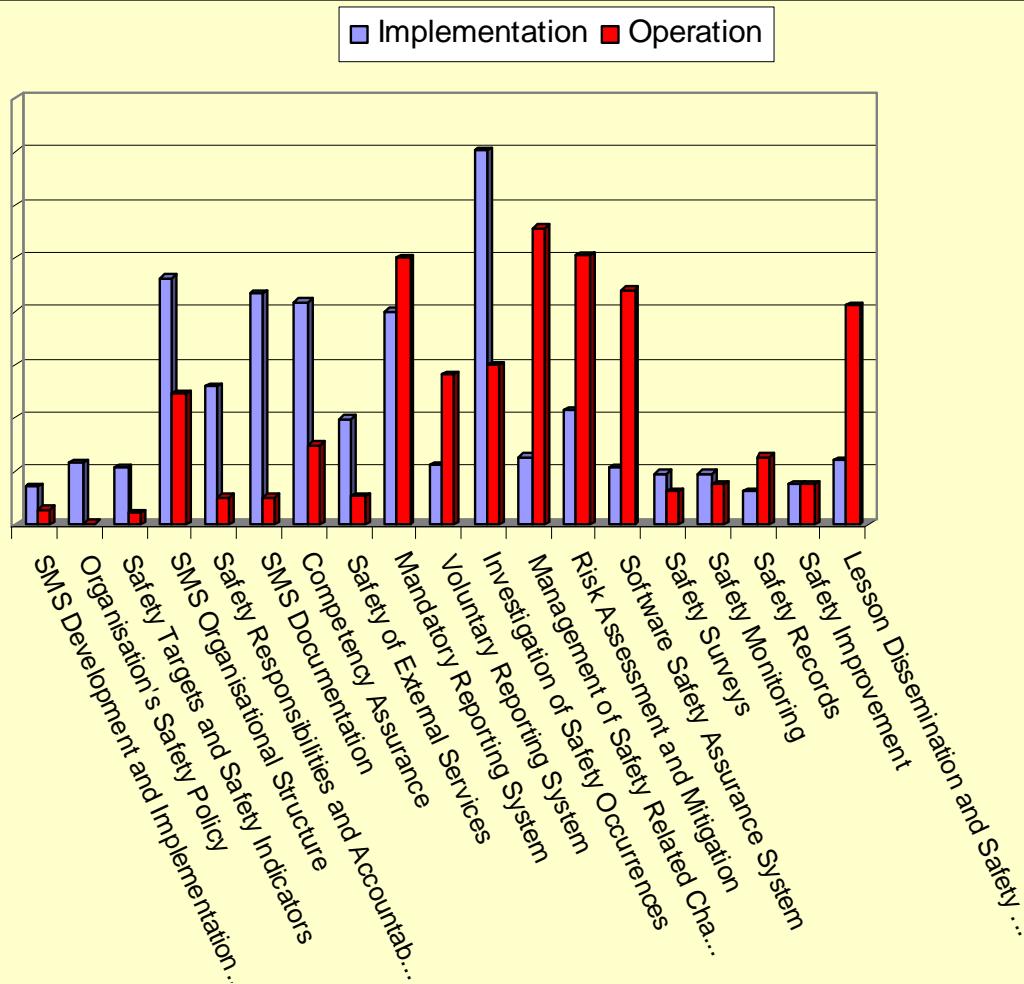


## Operation overall costs

- Mandatory reporting system – 13 %
- Management of safety related changes – 14 %
- Risk assessment & mitigation – 13 %
- Software assurance plan – 11 %
- Lesson dissemination & safety awareness – 10 %

Five procedures make up 61 %.

# Benchmarking Implementation vs. Operation



# Any Questions

