

1. BACKGROUND

In developing a safety management system, EUROCONTROL identified a series of safety assessment approaches which were aligned with the later development lifecycle stages of an operational concept. They focused mainly on formal safety hazard/impact/mitigation requirements assessment methodologies, which are used during concept definition and pre-operational preparations, and incident reporting when the concept is operational.

Safety Fundamentals was developed as an approach to pro-actively consider safety **early in the development lifecycle of the operational concept**. It is applied at the earliest stages of concept definition and development, and identifies the potential impact a concept could have in terms of qualitative indicators of:

- Safety Performance;
- Operational Safety;
- Safety Management; and,
- Regulation Framework.

The potential economic benefits of a proactive safety assessment and management approach are large and therefore there is a need to examine in more detail how Safety Fundamentals assessed through the Safety Screening Process link to the Cost Benefit Analysis approach used by EUROCONTROL.

2. DESCRIPTION OF PROCESS

The process developed by Icon, Deep Blue and Eurocontrol is designed to identify those safety aspects from Safety Screening which have potential economic impact and translate them into cost benefit items with a qualitative assessment of scale for input into EMOSIA.

Linking Safety Fundamentals to Cost Benefit Assessment will help to ensure that:

- Safety-related gaps in the concept design (which could lead to benefits being eroded) are identified early on;
- The cost of the change under consideration is not underestimated because important safety requirements are not taken into account;
- The impact of good safety design on reducing the cost of implementation is also taken into account.

The process steps are outlined in Figure 1 below.

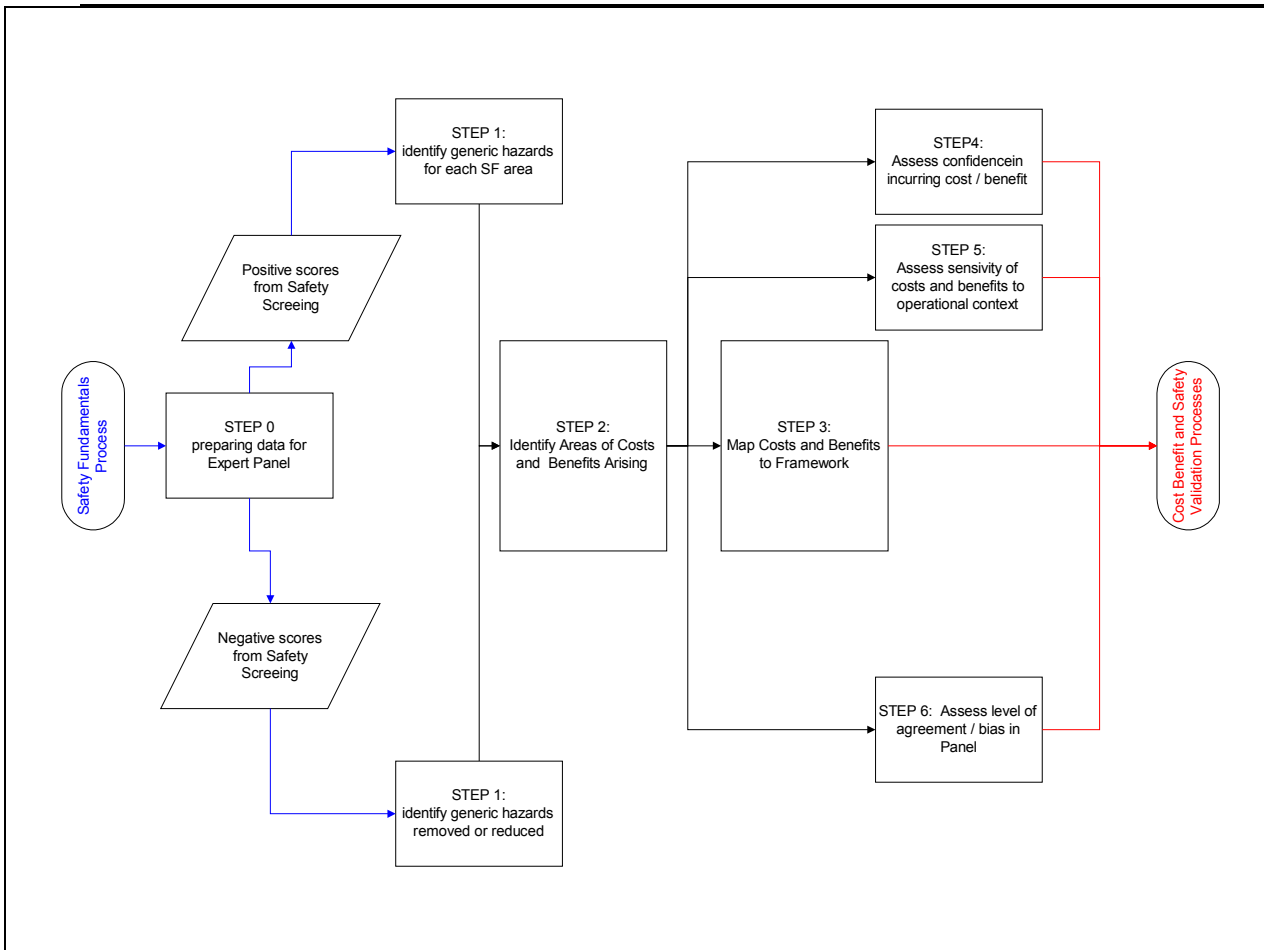


Figure 1 The Overall Process

Step 0, the Preparation Phase, prepares data from the Safety Screening process for use by an Expert Panel consisting of experts in safety, cost benefit as well as experts in the operational change under consideration .

In **Step 1**, the Expert Panel identifies the ‘generic hazards’. Gaps or errors identified under Safety Screening lead to ‘generic hazards’ (generic because they are typically common to any system or process¹). The Safety Screening Technique describes the Safety Fundamentals as **safeguards against generic hazards**. Removing / mitigating any generic hazards helps to ensure that **target operational benefits** are achieved. However, removing or mitigating generic hazards may also give rise to **additional costs** in the development and implementation of the change, and may also cause additional maintenance costs and/or a shorter operational life. On the other hand, improved process / early identification of these issues, or the selection of a more effective option may lead to reduction in those process costs.

The aim of this process is to identify these potential costs / cost avoidance.

Having identified the the generic hazards in Step 1, in **Step 2** the Expert Panel now considers the impact these may have on the delivery of the target operational benefits. This in turn indicates the key areas where additional cost may be incurred or avoided.

Note that it is not intended to show that Safety considerations are *responsible* for a given operational benefit (such as increased capacity), only that the results of the Safety Screening technique have identified that particular safety considerations in the design have the potential to augment, enable or offset identified target benefits.

¹ For example ‘single error/failure affects multiple safety barrier’

An influence diagram is recommended as a simple workshop technique to establish logical connections, and record the traceability, between inputs and outputs: in this case, safety fundamentals and intended operational benefits.

In **Step 3**, a cost benefit framework is populated to show:

- the areas of cost and cost avoidance arising from the issues identified in Step 2;
- where possible a first **qualitative** indication of magnitude, and
- an indication, if appropriate, of where target operational benefits may be augmented.

The populated cost benefit framework can be used in the Cost Benefit Assessment process to prioritise which elements of the cost benefit framework require further detailed quantitative consideration in later stages of the concept development, and to consider the trade-off between the cost of improving the design vs. the cost of not achieving the full level of benefit intended.

Step 4 consists of identifying the confidence placed by the Expert Panel that the identified costs and benefits will arise. Confidence will depend primarily on the level of uncertainty in the information available on the operational concept on which this assessment has been based.

The level of uncertainty about the results of this assessment will also depend upon the sensitivity of the described concept to the operational context. The description of the concept will have made some assumptions about the operational context in which the concept operates. **Step 5** asks to what extent the identified costs and benefits are affected by changing these assumptions, i.e. will the concept's safety related cost and benefits be changed by changing the operational environment?

Thus **confidence** depends on the degree of certainty about the subject itself, whilst **sensitivity** depends on the degree of certainty about the environment within which the subject will be implemented.

The approach proposed is based on expert judgement. However, expert judgment is subject to well known errors and biases. In particular, group dynamics and personal attitude may influence the way in which consensus is reached and the results achieved. **Step 6** will assess the bias and agreement between the expert panel participants, using a "Consensus ranking" technique.