

# Risk-Based Indicators Implementation and Usage

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## ABSTRACT

This article focuses on risk-based indicators, which are one of the subgroups of safety indicators. Risk based indicators are based on the idea of measuring changes of the overall risks of the operation, depending on the changing risk of sub-processes. This works on the principle of risk assessment of top events (accidents, incidents) using risk assessment of each component in the chain of events leading to the top event. Riskiness of the top events varies depending on the change in the number of occurrences of partial events in normal operation. Realization of these partial events does not automatically implement top event, but has the potential to create a chain of events that ultimately lead to the realization of top events lead. These factors, which leads to the realization of top events, should be identified thanks to the monitoring of normal operations and on knowledge gained by analyzing investigations into incidents and accidents. The article describes a system for identification, collection and analysis of data necessary for finding factors and these factors with the introduction of risk based indicators and detailed process leading to the establishment of the search system.

**Keywords:** Safety, Indicator, Taxonomy, Practical drift, Risk.

## 1. INTRODUCTION

Bezpečnost letecké dopravy pokročila za sto let letectví dalekou cestu a v současné době je měřena na pravděpodobnost fatální nehody na hodnotu  $1 \times 10^{-7}$ . Cesta k současným číslům vedla přes zvyšování bezpečnosti prostřednictvím zlepšení techniky, zaměřením na lidského činitele, organizační faktory. V současné době je zlepšení bezpečnosti pomocí konvenčních metod již méně efektivní a je třeba najít nové nástroje. Moderním prostředkem, který se dostává v letectví do popředí, je zavádění bezpečnostních indikátorů. Bezpečnostních indikátorů je několik druhů a jedním z nich jsou tzv. risk-

based indikátory umožňující sledovat změnu rizika a na základě získaných dat poskytnout pomocný nástroj pro rozhodování bezpečnostního managementu v oblasti efektivitu přijímání bezpečnostních opatření.

## 2. SAFETY INDICATORS

Safety indicator is an indicator which has to provide to safety staff an overview of the events that occurred. However if this was just a list of occurrences, this would be a fairly ineffective tool. The added value of safety indicators in functionality, that every safety indicator is linked to other processes within the organization and it is clear how the indicator values change affect other processes.

### 2.1 Types of safety indicators

Safety Indicators can be divided in several aspects. The basic dividing is into so-called leading and lagging indicators. This dividing also represents a difference in the effectiveness of monitoring. Lagging indicators are indicators following the occurrence of "only" top level events. That means occurrences of events that cannot develop to further occurrences and it is impossible to prevent their destructive potential only by their monitoring. By an airline it could be e.g. a number of events such as "Runway Excursion", but also the occurrence of an event type "Birdstrike". From these indicators, the safety management will receive good overview of the events occurrences but in terms of adopting safety measures it is not a very effective method. It is suitable for monitoring such events where there is no potential for frequent major damage or the events of this type cannot be avoided (birdstrike). The second large group of safety indicators are leading indicators. Using these indicators, it is possible to monitor the sub-events that have the potential for further development to the top events with big consequences. Using these indicators, monitoring, evaluation, it is

possible to adopt measures which will lead to the elimination of operational deviations, thereby preventing the development up to the peak of the event. This group of indicators is thus more efficient than the previous one. However, one cannot say that only the leading indicators are the right ones, we should use both leading and lagging indicators.

To this group of indicators also include risk-based indicators that provide information on what to focus on.

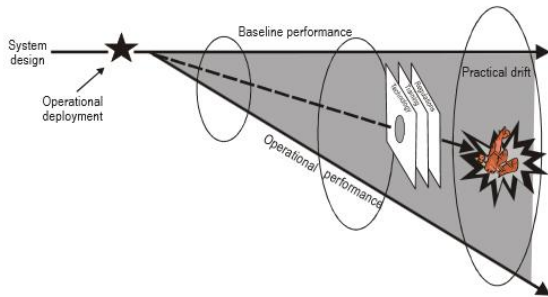


Fig. 1 Practical drift (ICAO SMS manual)

Characteristic of safety indicators is good measurability and therefore it is necessary for each safety indicator to determine variables, which will be measured, and it is good to bear in mind that measurable characteristics linked together and could be compared with each other.

### 3. SELECTION OF SAFETY INDICATORS

To establish the initial base of safety indicators it has to be defined area that will be evaluated. For these areas, it is important to build process models, which will include all sub-processes, and these models is needed to develop by the "accidental" events, i.e. implement probable deviations and factors of these deviations the model that

indicate potential for the development of adverse events.

For the definition of the factors it is possible to use some tools, such as different taxonomy developed for each part of aviation. The most comprehensive ICAO ADREP taxonomy is affecting all areas of aviation. For establishing safety indicators is useful mainly the sections devoted largely to factors (explanatory factors, descriptive factors).

In the next chapter, a brief description of the methodology, how to implement safety indicators, mainly the risk-based indicators.

### 4. IMPLEMENTATION OF RISK-BASED INDICATORS

For the risk-based indicators applying it is important to go through all company processes and construct a chain of events that lead to the realization of the top events - the so-called critical scenarios. To these critical scenarios is necessary to find the factors that occur during their realization. Factor can be understand such as a bad set procedures, intention to disregard company procedures, incorrect documentation, but also the level of safety culture, etc. Each of these factors has its own contribution to the realization of the event - the likelihood of the top event realization when the realization factor is going to occur. This factor can be taken just as risk-based indicator. Graphical representation of normal operation with realization of some factor and the change of the overall risk is shown below.

#### 4. 1 Example

One example is an event which is related to the aircraft maintenance. As an event we can have engine blades damaging by a foreign object (forgotten screwdriver). In this case, there could be many factors that lead to implementation. These are:

- Laziness of employees to control their tools

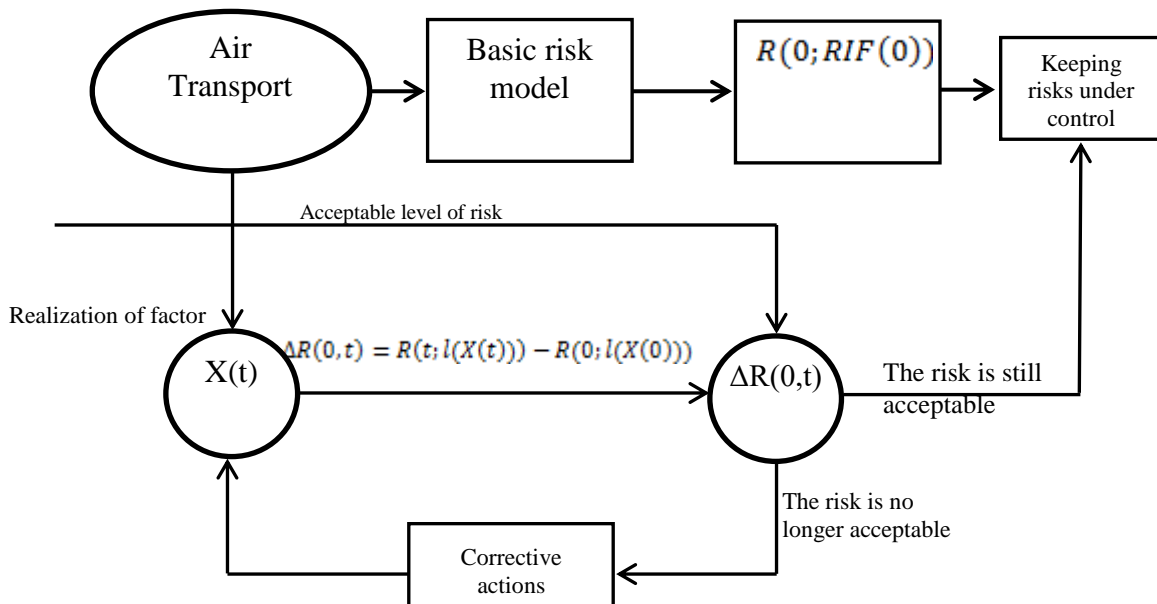


Figure 1 Scheme of risk assessment thanks to the factor realization [3]

- Inconsistency of control mechanisms when after each shift is necessary to check the completeness of employees set of tools
- Another possibility is to use unlabeled tools that anyone missing
- Failure to comply with prescribed procedures for using tools
- Etc.

So if there is some factor from the list above, there is a possibility of top-event realization. And the possibility increase with the number of realization of these factors. From the above list, it is clear that there could be several factors to one event. If we evaluate these factors in terms of their contribution to the realization of a hazardous event, we have risk-based indicators. By the monitoring and evaluation of these indicators, we can take targeted safety measures and thus effectively prevent adverse events.

## 5. CONCLUSION

Using risk-based indicators in aviation help to guide safety department workers in the current problems, which occur in the normal operations, without the realization of top events. The indicators should fulfil the warning function, and therefore it is advisable to choose them as factors contributing to the event. Risk-based indicators are still the property of alphanumeric risk value of the top events, and thus provide an opportunity to choose the area for corrective measures with higher priority than another.

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