Methodological Overview on the Indicator Creation Process
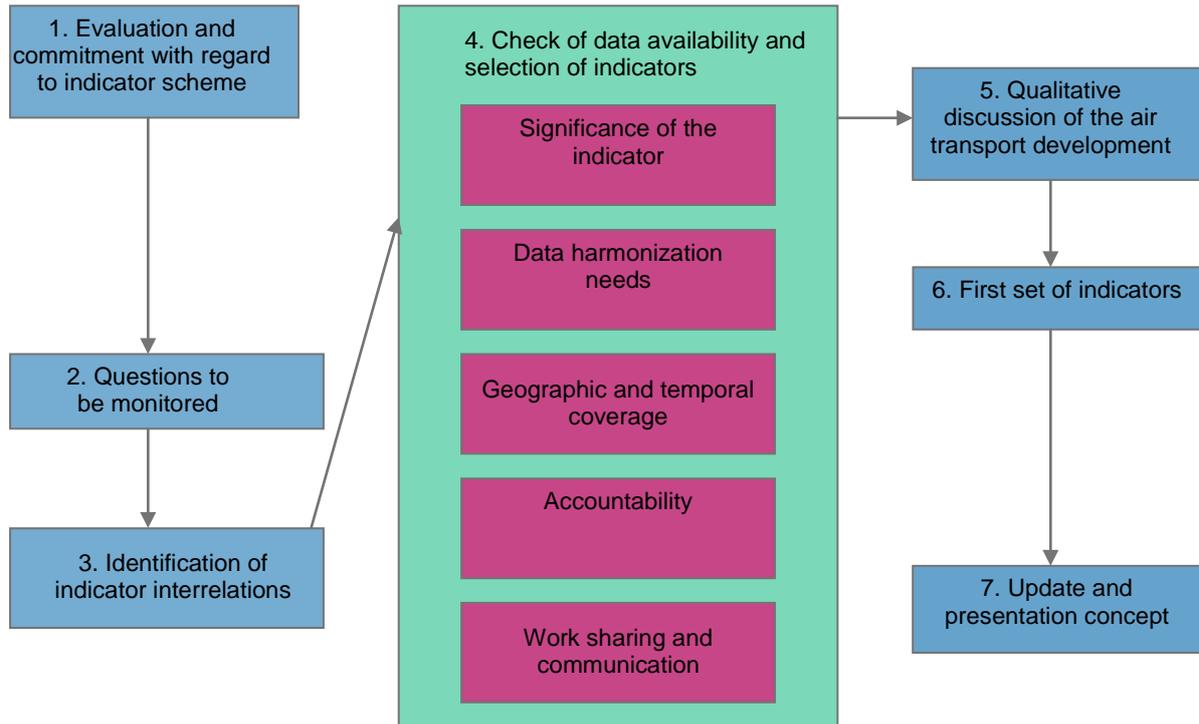
The preliminary set of indicators on air transport development which was elaborated within the MONITOR project is the outcome of a strategic process that will be described in the following. The elaboration process was guided by a clear work plan as it is presented in the following chart.

Process of indicator creation

Based on this process seven working steps were defined which will be explained in the following.

Step 1 (Evaluation and commitment with regard to the indicator scheme)

This working step included a discussion of the MONITOR project team to decide under which perspective and to what extent an indicator scheme could be used as an approach for monitoring the air transport development over the long-term. In addition, suggestions of the MONITOR Advisory Committee and of the different aviation stakeholders which answered the Experts' Survey were included to improve the first ideas and to elaborate a concrete concept for an indicator scheme. The outcome of these activities is summarised in the following chart:
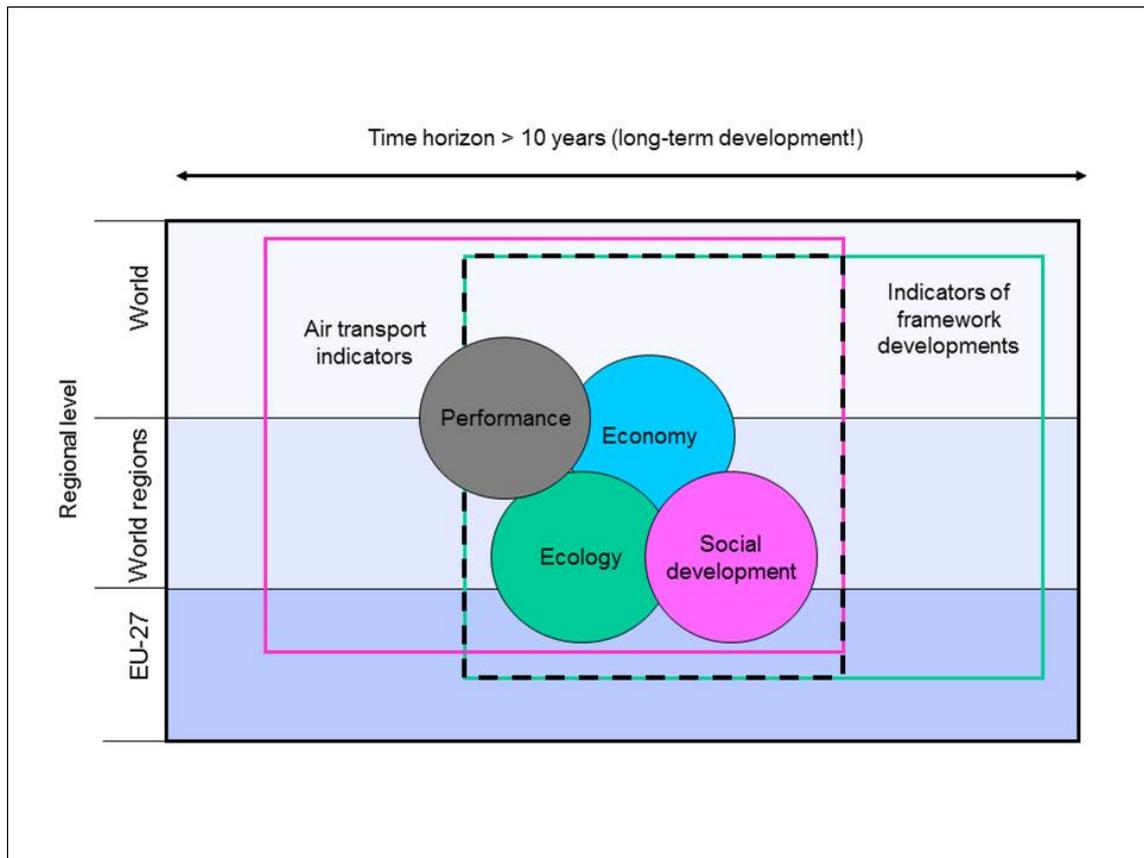
When regarding this graph it has first to be mentioned what the term **"Indicator"** means in the context of the MONITOR project as this term is nowadays often used in different scientific contexts which are not based on a common understanding. With regard to the MONITOR project an indicator is always understood as a figure that represents one component of the air transport development by combining two or more measures or values. So, in general, this means that an indicator puts always two or more aspects (or **Key Measures (KMs)**) in a context to realise a higher significance of the regarded topic.

From this point of view an indicator in the understanding of the MONITOR project can be based on key measures that belong to the air transport internal dimension or on the combination of key measures that belong to the **air transport internal and external dimension**. This scope is marked in the picture above by the orange and red oblongs that represent the perspective for building indicators in order to monitor the long-term development of trends and challenges in aviation. Within this scope two types of indicators can be distinguished:

- **Performance Indicators (PIs)** which measure the fulfillment of the main purpose/task of the air transport system (i.e. its transport function)

- **Sustainable Development Indicators (SDIs)**, measuring:
  - the **economic development** (combination of air transport internal and external dimension)
  - the **ecological development** (combination of air transport internal and external dimension)
  - the **social development** (combination of air transport internal and external dimension)

As a conclusion PIs are signified by an air transport internal point of view which means that these indicators solely look at the question how the air transport system develops with regard to performance and traffic figures, while the focus of the SDIs is to understand also the relation between air transport internal and external developments and to show how they influence each other with regard to the economical, ecological and social objectives that are important with regard to a sustainability approach.

Furthermore, as it is indicated in the graph, **different geographic levels** for the indicator monitoring concept, which was developped in the project, can be distinguished:

- World
- World region level
- EU-27

In this context, the most important level is the global one as the MONITOR project has a very broad and long-term focus in order to identify only the most relevant and pressing trends and challenges with regard to aviation development. Therefore, the preliminary set of indicators which was developed within the MONITOR pilot study concentrates on this geographic level. Nevertheless, due to data gaps, some indicators were also only calculated for several world regions which replace the **global perspective**. However, in the long-term it is of course thinkable to break down some indicators to a further lower geographic disaggreagation (e.g. EU-27).

In addition, for the future a change in the temporal focus is thinkable. Anyhow, within the MONITOR project a **time horizon** of more than **10 years** for the preliminary indicator set was chosen. This represents a good base for historic time series as it allows to present a long-term view which is reliable enough to identify general trends and to estimate roughly how the regarded trends will develop in the future. Furthermore, this approach also fits to the other two pillars of the MONITOR project – the **(meta-)database** and the update of the **CONSAVE 2050 scenarios** – as both elements also focus on long-term strategic views and foresee a global coverage. So, synergies and relations between the three pillars of the monitoring system are realized.

Step 2 (Questions to be monitored)

Based on the outcome of working step 1, step 2 included the further specification of general topics which should be monitored with the indicator approach as it was defined on the base of the considerations described above. This was done by formulating questions which should be answered by the indicators to be built.

As the necessary prerequisite to build indicators is to combine key measures it was in this context clear very quickly, that a first set of those questions should aim at identifying key measures. A second set of questions was then formulated to secure that all important topics are covered by the planned set of PIs and SDIs. Finally, the set of questions for key measures and indicators was then adapted to each other for consistency purposes. The outcome of these activities is reflected in the following set of questions which is not aiming at being complete but served as useful guideline for the further work process in order to identify necessary KMs and indicators to be monitored:

A. **Questions – Air transport external developments (How did the world change in the regarded time period)?**

A-1. Key Measures (KMs) of Framework Developments

1. Which changes occurred w.r.t. the area of demographic development and society?
   a. Size of the world population
   b. Average age/ageing structure
   c. Poverty

2. How did the economic development change?
   a. GDP
   b. Volume of external trade

3. What is the situation on the oil/energy market?
   a. Oil price development
   b. Energy consumption per capita
   c. Oil production rate
   d. Crude oil availability
   e. Energy mix (share of biofuels w.r.t. total energy supply/consumption)

4. What is the situation with regard to the environment?
   a. CO_2 emissions
   b. Green house gas emissions
   c. Noise
   d. Land use

5. What happened in the mobility sector?
   a. Pkm
   b. Modal split
   c. House-to-house travel time
   d. House-to-house travel costs

B. Questions – Air transport internal developments (What is the development in the air transport sector in the regarded time period?)

B-1. Key Measures (KMs) of Air Transport Development

1. Air transport demand
   a. Passenger volume, PKM
   b. Freight volume, TKM

2. Air transport supply (Airlines)
   a. Number and kind of airlines (FSNC, LCC)
   b. Number and kind of flights (domestic and international)
   c. Kind of offered services (Hub-and-spoke system vs. point-to-point system)
   d. Number of accidents

3. Air transport infrastructure (Airports and ATM)
   a. Number of airports
   b. Capacity of airports

4. Air transport technology
   a. Number of aircraft (global fleet)
   b. Fleet mix (according to aircraft types/size)
   c. Specific fuel consumption
   d. Average age of aircraft
   e. Life cycle duration of a typical passenger aircraft

5. Environmental issues
   a. Total fuel use and total CO_2 emissions
   b. Total NO_x emissions
   c. Total noise emissions

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    d.   Total land use

B-2. Performance Indicators (PIs)
System internal point of view: How efficient is the performance of the air transport system? Is the system in itself efficient with regard to the objective to fulfill its basic function?

1. Which trends are visible in the airline sector?
    a. Number of flights/aircraft
    b. Number of passengers/aircraft
    c. Amount of freight/aircraft
    d. PKM/TKM per aircraft
    e. Number of flights/employee (labour productivity)
    f. Average costs/aircraft kilometres
    g. Average revenue per PKM, TKM, passenger, transported tonnes, flight
    h. Degree of competition (per route/region etc.)
    i. Punctuality

2. Which trends are visible in the airport sector?
    a. Number of flights/runway
    b. Average number of passengers, average amount of freight per airport
    c. Total amount of passengers, total amount of transmitted freight per airport employee
    d. Average costs (airport fees)/movement
    e. Average revenue per passenger, tonnes of freight, flights

(Similar questions can be raised for ATM but will be excluded here as those indicators are broadly investigated by the Performance Review Commission of EUROCONTROL).

B-3. Sustainable Development Indicators (SDIs)
System external point of view: How develops the air transport system with regard to the three pillars of sustainability?

3. Which contribution offers the air transport system with regard to the macroeconomic development?
    a. Employment (e.g. employee per traffic unit)
    b. GDP contribution
    c. Traffic productivity
    d. Competition between air transport and other transport modes

4. How developed the ecological situation with regard to the air transport sector?
    a. Fuel use and CO_2 emissions (specific)
    b. NO_x emissions (specific)
    c. Noise emissions (specific; footprint and number of people in 55/65 dB areas)
    d. Land use (specific)

5. Which contribution offers the air transport system with regard to the (mobility) needs of society?
    a. Number of flights between regions (connectivity/frequency)
    b. Number of flights/trips per capita
    c. Average length of flights
    d. Fares
    e. Safety

Step 3 (Identification of indicator interrelations)

This step was included in the working process to discuss possible indicator interrelations which should be addressed in the overall analysis in order to provide also a view on the whole air transport system and the relation between its individual components. This

supported the structuring of the indicators within the final indicator set and was also an input for the indicator information sheets which were created at the end of the project and which form the base for the indicator monitoring system on the MONITOR website.

Step 4 (Check of data availability and selection of indicators)

Based on the outcome of the previous steps, step 4 represented the most important but also the most challenging part of the work as it included the final selection for a preliminary set of indicators and a parallel data check in order to provide the necessary KMs for building these indicators.

To facilitate these activities some additional requirements were formulated which guided the work process.

4a. Significance of the indicator

In order to come to an optimized cost-benefit outcome when collecting and harmonizing data for the indicators it was argued that all indicators which were candidates for the preliminary indicator set should have a special significance. The selection of this outcome summed up the results of the MONITOR Experts' Survey, suggestions from the Advisory Committee and the concrete thematic scope of the indicators which were an outcome of the questions formulated in step 2. So, when working step 4 was initiated, a clear estimation of the importance of special indicators in contrast to others was already given what led to a pre-selection or "wish list" of indicators for which a data availability check was done in the first instance.

4b. Data harmonization needs/Geographic and temporal consistency to the indicator scheme

By realizing the selection of significant indicators extended desk research was taken out to identify data sources for building the indicators. In this context the (meta-)database, which was also elaborated in the MONITOR project, was a very good support, as it provided a fast and extended orientation on useful data sources but also on data harmonization needs. The first requirement for the following harmonization process was that the chosen data should cover the geographic horizon (global level) and the temporal horizon (>10 years) that had been defined before. This was a challenging task for several indicators, as in some cases only short-term data was available or the global coverage could not be reached to a complete degree.

The main solution, which was followed in this situation, had then been to look (1) if geographic and temporal consistency could be reached by combining different data sources or choosing completely other sources or (2) if a cut back of the general requirements is acceptable given the result that the significance of the indicator does not suffer from this cut back. The latter solution was e.g. used with regard to indicators on punctuality for which larger-scale data was only available for Europe and the U.S. (cut back from geographic consistency) or with regard to indicators on the traffic performance at airports. In this case only data for four years in the past was available (cut back from temporal consistency). Such solutions were regarded as useful in the overall context as the alternative would have been to leave the corresponding indicators completely out of scope and to reduce the set of indicators and the monitoring scope significantly.

Further data inconsistencies also appeared when different figures taken from different sources were combined. Financial data has e.g. to be given in the same currency to be summed up and the question which currency exchange rate at which date will be taken to harmonize such data plays an important role in this context. Other key measures were based

on a different definition of world regions what made it necessary to adapt these geographic resolutions to each other and to reach a common standard.

All these tasks required a very detailed analysis of the chosen data sources and a careful estimation about chances and boundaries with regard to their significance. In case, two or more data sources were completely not combinable it was therefore decided not to use them and to abandon to present the linked indicator. Otherwise, it was taken care to hint at the limited significance of the underlying data sources with regard to the indicator presentation on the MONITOR website. So, especially in step 4 highest emphasis was put on a documentation of the corresponding working steps.

4c. Accountability (Responsible persons/institutions for the indicator development)

Concerning the further selection of data sources and indicators it was not only tried to hint at interrelations between different indicators but also to hint at the accountability. This meant to identify and discuss the role of different air transport actors with regard to the development of the regarded indicators. Special emphasis was put on this task already in the data collection phase.

4d. Work sharing and communication

The indicator selection and data harmonization process involved also an intensive dialogue within the MONITOR project team. This was realized by regular meetings during the project's life time and by the design of an indicator information sheet, which served as standardized template for the indicator creation process (cf. also Step 6). In concrete this template involved in its final version the following categories:

Subject	- Air Transport Development
Kind of indicator	- Performance Indicator - Sustainable Development Indicator
Spatial objective	- Worldwide
Object	- Trends at Airlines - Trends at Airports - Effects of Air Transport on the Economic Development - Effects of Air Transport on the Ecological Development - Effects of Air Transport on the Social Development
Purpose of the indicator category	Monitoring field: What is expressed with the indicators?
Description of the indicator development	Graphical illustrations and analysis of the past and current indicator development
Main sources of the discussed indicators	Data sources as origin of the indicators
Alternative sources to build similar indicators in the given indicator field	Description of alternative data sources which can be used instead of the main source to build indicators in the same thematic field

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Step 5 (Qualitative discussion of the air transport development)

This step mainly included a discussion on the air transport development which is reflected in a pre-choice of indicators as outcome of step 4. In this context, step 5 mainly served as quality assessment of the results given at this point. It should be proven if the so far chosen indicators are sufficient with regard to the MONITOR objective to provide a qualitative analysis of the air transport development. This opportunity was especially demanded by the MONITOR Advisory Committee and the aviation experts, which participated in the MONITOR Stakeholder Workshop on behalf of the project's lifetime. The general opinion there was that the approach is useful and reliable enough to be extended to a monitoring system.

Step 6 (First set of indicators)

Based on the outcome of step 5 the task of step 6 was to decide about the final design and content of a first set of indicators which should in the future continuously serve the purpose to monitor the air transport development and to report on new trends and challenges. Taking into account the results of the previous working steps this final indicator set, which also formed the base for the indicator presentation on the website, consists of the following structure and elements:

KPIs: Key Performance Indicators of Air Transport Development

1. Trends at airlines

1a. Airline Fleet	1b. Airline Traffic Performance	1c. Airline Financial Performance
Average number of aircraft in service per airline	Average number of departures per aircraft	Average revenues per airline
Share of stored aircraft compared to total number of aircraft	Average number of passengers per aircraft	Average operating expenses per airline
Number of aircraft orders per 100 aircraft in service	Passenger load factor	Average operating result per airline
Share of aircraft size classes	Average total tonne-kilometres per aircraft	Average operating margin per airline
Average age of aircraft	Average number of departures per airline employee	Average net result per airline
	Percentage of departure and arrival delays	

2. Trends at airports

2a. Airport Traffic Performance	2b. Airport Financial Performance
Average number of movements per airport	Average revenues per top 100 airport
Average number of movements per top 30 airport	Average operating result per top 100 airport
Average number of passengers per airport	Average operating margin per top 100 airport
Average number of passengers per top 30 airport	Average net result per top 100 airport
Average amount of freight per airport	
Average amount of cargo per top 30 airport	

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SDIs: Sustainable Development Indicators of Air Transport Development

3. Indicators on economic aspects of air transport development	4. Indicators on ecological aspects of air transport development	5. Indicators on social aspects of air transport development
Development of freight tonne-kilometres per inhabitant in several world regions	Year-over-year percentage change of overall CO2 emissions and CO2 emissions in air transport	Number of passengers killed per billion RPKs
		Fatal accidents per 1 million flights
Economic specific flight development per world region	Change of the overall CO2 emissions and air transport related CO2 emissions between 1970 and 2005	Departures per 1,000 inhabitants per world region
Economic specific freight tonne-kilometre development per world region	Air transport emissions share in total CO2 emissions	Passengers per 1,000 inhabitants per world region
	Development of absolute CO2 emissions (all air transport emissions compared to total emissions)	Passengers per million US $ GDP
	CO2 emissions from air transport per 1 million passengers	
	CO2 emissions from air transport per 1 million passenger-kilometres	
	CO2 emissions from air transport per 1 million tonne-kilometres performed	

In summing up the elaborated indicators it can be concluded that a stable and balanced first set of indicators was built within the MONITOR project. The corresponding scheme involves in complete eight categories:

- **5 Performance Indicator Categories** (with about 26 single indicators) and
- **3 Sustainable Development Indicator Categories** (with about 15 single indicators)

Step 7 (Update and presentation concept)

The main requirement for presenting the elaborated indicators on the MONITOR website was to allow a fast and precise estimation of the added value of this pillar of the monitoring system. Therefore, it was decided to present a short introduction of the chosen approach, supported by a visual overview on the preliminary indicator scheme that can be extended and updated over time. This visual overview guides the user via a direct link to the indicator category that is of highest interest for him in order to allow every stakeholder a quick navigation through the website according to his preferences.

Concerning the individual indicator sheets there is furthermore the opportunity to get hints at important data sources which stand in direct relation to the elaborated indicators. This way the linkage between the indicators and the second pillar of the monitoring system, the (meta-)database, is realized.

To increase the usefulness of the indicator collection further it is planned to update several indicators each year. Nevertheless, this will only be done mainly for those indicators which still have a high relevance concerning the long-term air transport development. Meanwhile, it is also thinkable to introduce new indicators that reflect new trends and challenges. This way, it is secured that the MONITOR indicator set represents always the state of the art and is an enrichment for the field of air transport research. Within this context it is fixed planned to

consider stakeholder recommendations for the improvement of the indicator set as this set should finally serve the community of air transport experts and the interested public.