MONITORING AVIATION DATA: THE MONITOR SYSTEM

Andreas Wittmer, Center for Aviation Competence, University of St. Gallen

ABSTRACT

The main intention in connection with the Monitor project was to design, plan and realise a monitoring system that is capable of continuously describing and evaluating long-term trends and challenges within the air transport sector. The following objectives were addressed by the project:

- Gaining a better understanding of the dynamic nature of developments in air transport and the behaviour of the different actors within the aviation system

- Balancing economic interests, ecological constraints and social needs (sustainability approach)

- Generating input for scenario modelling and quantification exercises linked to ACARE Vision 2020+, EUROCONTROL's "Long Term Forecast", JTI Clean Sky Technology Evaluator

- Identifying necessary conditions for aviation growth in the field of technology development and within the macro and socio-economic framework

As a strong orientation on the requirements and needs of aviation stakeholders was regarded as an important prerequisite for this task, an advisory committee of aviation experts was established at a very early stage of the project in order to secure that an external view is included. Together with the outcome of an experts' survey, the project objectives and the expected results could then be defined in more detail. Given this work process, the final components of the monitoring system were designed and oriented on three pillars which were seen as essential to address the monitoring function linked to the project.

The monitoring system produced a flexible and upgradeable system that is capable of a permanent scanning and assessing of trends with relevance for the aviation sector. The broad focus of the monitoring system covers many important aspects from different perspectives. The results of the project are a meta-database on the major aviation issues, an indicator set providing a structure for monitoring the aviation industry and future air transport trends and scenarios.

Three pillars (Database on Data sources, Indicator System, Future Trends and Scenarios) of the monitoring system were combined and implemented on a webpage (www.airtransport-monitor.eu). On the basis of different indicators it is possible to compare different data from different sources.

Keywords: Aviation, Monitoring, Data

INTRODUCTION

There exists a variety of aviation databases used to analyse the industry and to derive trends. Different databases have different set-ups so that they are not fully compatible and cannot be combined. The monitoring system to be developed during the MONITOR study should help to understand the differences of different data source. The aims of MONITOR are:

- Gaining a better understanding of the dynamic nature of developments in air transport and the behaviour of the different actors within the aviation system

- Balancing economic interests, ecological constraints and social needs (sustainability approach)

- Generating input for scenario modelling and quantification exercises linked to ACARE Vision 2020+, EUROCONTROL's "Long Term Forecast", JTI Clean Sky Technology Evaluator

- Identifying necessary conditions for aviation growth in the field of technology development and within the macro and socio-economic framework

- Improving the competitiveness of the European aviation industry and strengthening the independency of European regulators according to policy decisions

- Disseminating the results of the project to the broad public in order to establish a long-term monitoring system for aviation development

The overall objective of MONITOR is to install a permanent monitoring system of external and internal key factors of strategic importance for aviation development and to establish an early warning system that hints at new trends and challenges for the air transport sector. As necessary prerequisite for reaching this aim the need to establish a network of sources for data, which is relevant for the elaboration of long-term scenarios and the assessment of the development of the aviation sector, was seen as most important task for the beginning of the Three priorities were seen as most important:

1. The establishment of a publicly available database with detailed meta-data, links and hints at relevant data sources dealing with air transport internal developments and relevant framework developments

2. The creation of an indicator set that allows describing and assessing the development of the aviation sector with regard to long-term historic trend lines.

3. The elaboration of an update of the estimation on the long-term air transport development up to 2050 in order to support strategic planning and the added value of the data collection in an analytical context

MONITOR CONCEPT

Based on the objective that MONITOR should allow for permanent monitoring of the aviation industry and contribute to a better understanding of the dynamic value of developments in air transport for strategic and public decision makers and for academia, the system was built on three pillars:
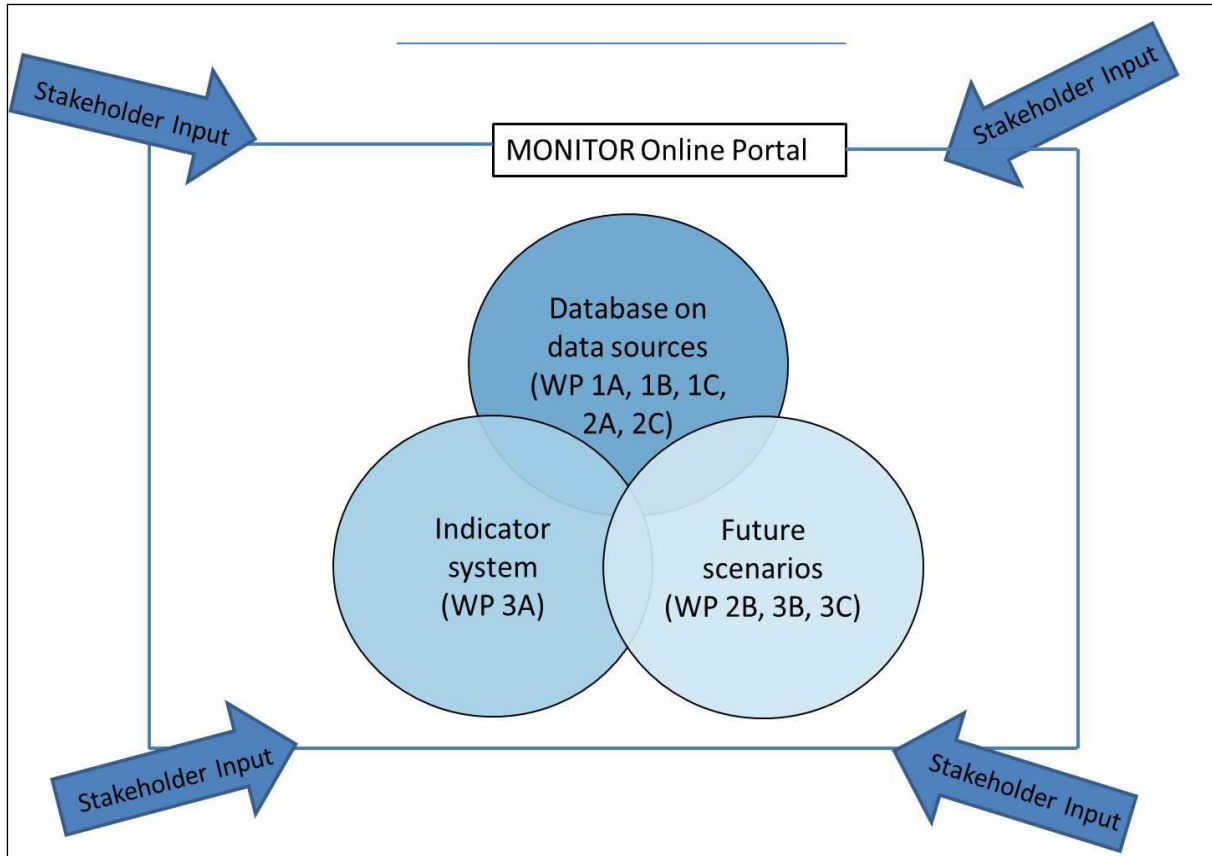

Figure 1: Concept of the MONITOR monitoring system

Figure 1 shows the three pillars – namely (1) the MONITOR meta-database, (2) the MONITOR indicator system and (3) the future aviation scenarios. In addition, it can be recognised that the three pillars must be seen in connection to each other, as the monitoring system gains its importance and reliability especially from a systemic approach that covers different analysis instruments and perspectives in linkage to the air transport system. A second view also shows how this linkage is formally designed. Within this context, the MONITOR portal serves the purpose to show the connection among the three pillars formally and technically. It represents the operational platform for the presentation and use of the monitoring system. In addition, the graph above also highlights the preliminary character of the current system. As the MONITOR project was a pilot study to elaborate and test suggestions how a monitoring system for the aviation sector could be built, the system is considered as being a flexible one. This was regarded as one main priority for the build-up of such a system, as stakeholder estimations and altered expectations can make it necessary to change or extend the given monitoring pillars over time, if different developments take place in the aviation sector, which make a switch in the monitoring methodology necessary. Therefore it is very important to stress the flexible character of the above described systems besides its systemic nature.

In the following, the function and value of each monitoring pillar in the context of the whole monitoring system will be described in more detail.

1. Monitoring function of the Meta-Database

Without adequate data no analysis of the state-of-the-art of the air transport system is possible what makes strategic decision making very difficult and risky. Resulting from these conditions it becomes clear that every scientific monitoring approach requires first a suitable information base in order to fulfil its basic function and to allow deeper analyses with regard to different research questions. In the first instance, a scanning, selection and harmonisation process concerning air transport relevant statistics and data is necessary. Following this approach, the base for a reliable, manifold and detailed so-called "network of sources" could be built, which offers all interested actors a freely usable information base on relevant air transport data but also on important framework data sources. The data sets contain in this context statistics, webpages, project reports and many other reference sources which are regarded as useful and established information sources that can serve to describe, analyse and evaluate the air transport development in the long-term on a global scale.

2. Monitoring function of the Indicator Set

An analysis of the observed data was needed to structure the data so it allows dedicating relevant conclusions Given the outcome of the MONITOR experts' and the recommendations of the Advisory Committee in this context, the mentioned stakeholder groups argued that they are in need of a flexible system which is capable of showing the most important topics in this context in a compacted and well-arranged manner what allows to get an overview on the most relevant aspects from their point of view. These needs led to the selection of an indicator approach, as this instrument allows to observe former long-term trends in air transport in a compacted, precise and fast way in order to a come to a conclusion on the most important drivers but also challenges with regard to the air transport sector. Due to this character the indicator approach within the MONITOR project was also strengthened by the collected and known data sources in the background which formed the base for this kind of analysis. In addition, the concentration on past and current trends and developments with the help of indicators profits from the aviation scenarios (third pillar), as these complete the users' view with regard to possible future trends.

3. Monitoring function of Future Trends & Scenarios

Strategic decision making requires on the one hand a detailed analysis of the past in order to avoid failures and to learn from historic decisions. However, detailed projections about possible future developments are on the other hand an indispensable guideline to reduce risks. Monitor dealt especially with the update of scenario-relevant framework data and important air transport related assumptions based on "CONSAVE 2050" scenario taxonomy. In addition, one of the former "CONSAVE 2050", i.e. the "Unlimited Skies Scenario" (ULS), was recalculated taking into account newest data and the updated assumptions. This assessment served in the monitoring context the purpose to complete the rather past and present oriented indicator view by a long-term outlook which addresses at the same time such important issues as air transport demand and supply, environmental problems, technology performance and policy aspects.

RESEARCH PROCEDURE

A monitoring system which shall allow strategic planning and reasonable decision making must be adapted to the needs of the target group which shall work with this system. Given this priority, highest effort was put in the establishment of the Advisory Committee as several important objectives were linked to this group of aviation stakeholders:

- Professional inclusion of stakeholder expertise in the project work

- Reflection of requirements of aviation stakeholders

- Advice on project objectives and approaches

- Balance of perspectives

- Broadening of the project's geographic diversity – support of a global approach

- Coverage of all relevant topics concerning air transport development

- Support within priority setting with regard to the foreseen build-up of a monitoring system for aviation

- Safeguarding of quality and relevance of the selected data with regard to the monitoring pillar "meta-database"

- Preparation and assistance in view of the planned Stakeholder Workshop

- Contribution in the Stakeholder Workshop

- Improvement of the public awareness of the project

- Supporting contacts to other relevant projects

- Creative impulse for prospective research fields and future

In addition, it was foreseen that the Advisory Committee contributes to the whole MONITOR work process at each important step of the project development (cf. figure 3).

Addressing these priorities, the selection and establishment of the Advisory Committee was given highest attention in order to have a well-balanced mixture of aviation professionals aboard. For this purpose it was foreseen already in the project planning stage that the Committee should consist of representatives from different fields in order to reflect manifold perspectives on the aviation system and to consider their needs and requirements with regard to the intended monitoring system. Taking into account this objective, experts from the field of industry, politics and science were chosen. The concrete selection of the Advisory Committee took then place in form of an invitation letter which introduced the project, its objectives and its final outcome to those potential Advisory Committee candidates who had already declared their support for the project during the proposal elaboration process. Based on this, finally 12 representatives agreed in participating in the Committee and were invited to the first Advisory Committee Meeting. The following table lists them in connection with their activity area.
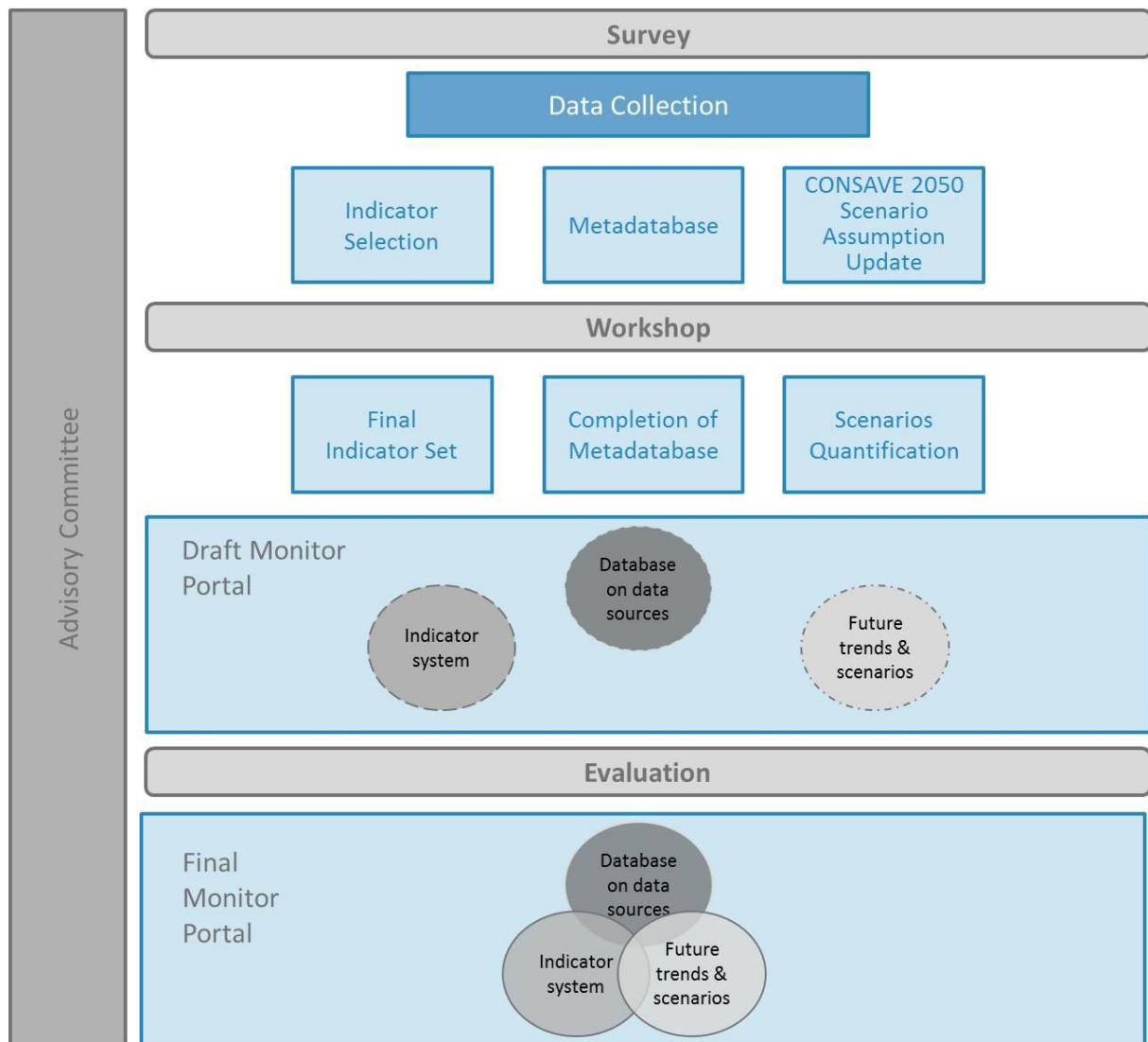
Figure 2: Advanced workflow of the MONITOR project

Concerning the methodology which was used for the Stakeholder Survey it was decided to perform an online survey as this guaranteed to reach the highest number of interested persons and to facilitate the access to the questionnaire for this group in order to maximize the feedback. The high number of answers showed in the end that this approach was appropriate. The selection of the potential participants was concentrated on getting a mixture of different aviation experts aboard. Within this context it was addressed to a broad range of possible interested stakeholders – stemming from address lists of the project partners and from Advisory Committee members - mainly belonging to the following fields:

- Airports
- Airlines
- Aircraft Manufacturing
- Policy Making
- Air Transport Research and Consulting
- Environmental Research

312th WCTR, July 15-18, 2013 – Rio, Brazil

In addition, it was taken care to address people from all over the world in order to include an international perspective.

In parallel to the selection process of possibly interested survey participants, the work on the questionnaire started. Finally, it included four sections:

A. Personal Background

B. Fields of Interest

C. Your Current Information Use

D. Preferences for Data Formats

These four sections included 24 questions, whereof the main questions were concentrated on the sections B and C. Part D was foreseen as a voluntary part in order to additionally improve the outcome and to avoid that people stop to answer the questionnaire if they have the feeling that it takes too much time.

Figure 3 shows the network of sources used in the context and process of conducting the MONITOR project.
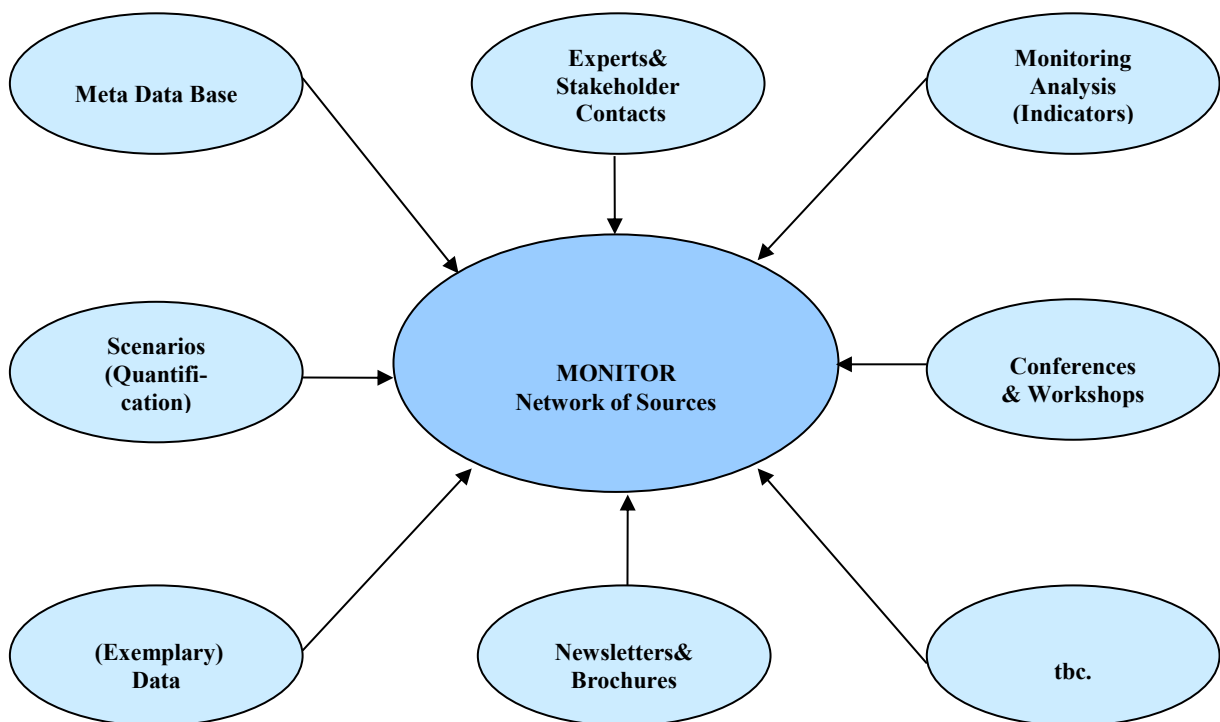

Figure 3: Vision for the MONITOR "Network of Sources"

ANALYSIS AND FINDINGS

1. <u>Definition of a database structure</u>

After the target group was known, the structure of the database had to be developed. From already existing research in this field, it was seen as advantage to work with a structure that arranges data with regard to its content in the first instance. In addition, the development of main categories and sub-categories was seen as useful in this context to differentiate further between the data sources. This allows especially un-experienced users to search for data which is of interest to them step by step in an iterative way. On the other hand, the sub-categories should also be kept general and not too limited as this creates allocation problems with regard to data sources that cover lots of aspects of the air transport system at the same time. Addressing these challenges, the database structure (figure 4) was developed as final concept. It includes eight main categories and 26 sub-categories.
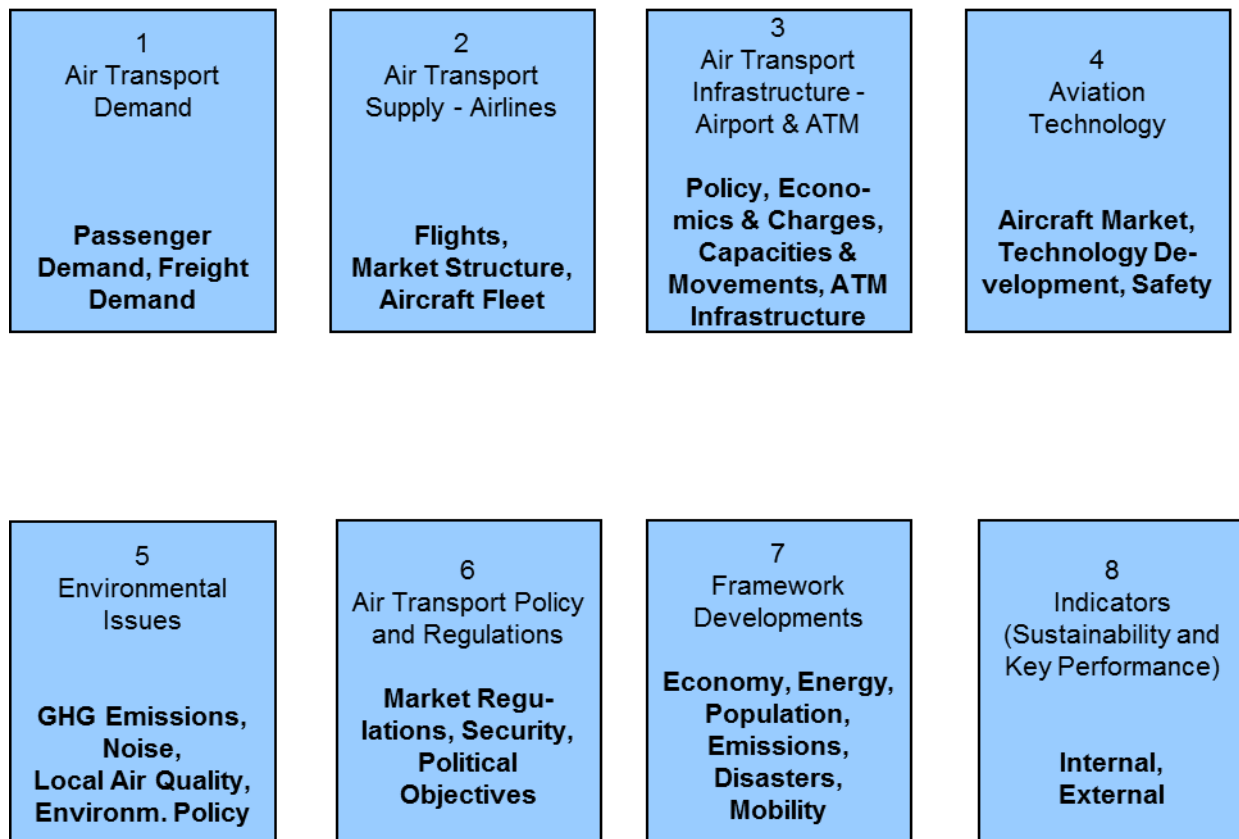
1 Air Transport Demand **Passenger Demand, Freight Demand**	2 Air Transport Supply - Airlines **Flights, Market Structure, Aircraft Fleet**	3 Air Transport Infrastructure - Airport & ATM **Policy, Economics & Charges, Capacities & Movements, ATM Infrastructure**	4 Aviation Technology **Aircraft Market, Technology Development, Safety**
5 Environmental Issues **GHG Emissions, Noise, Local Air Quality, Environm. Policy**	6 Air Transport Policy and Regulations **Market Regulations, Security, Political Objectives**	7 Framework Developments **Economy, Energy, Population, Emissions, Disasters, Mobility**	8 Indicators (Sustainability and Key Performance) **Internal, External**

Figure 4: Structure of the MONITOR meta-database

2. <u>Definition of a meta-data concept</u>

Experts, who deal with the long-term development of air transport, face the problem of filtering relevant information acquired from numerous sources. On the other hand, often the required information is not available. The MONITOR meta-database was in this context designed to provide its target group with a first orientation of the available data required for the analysis of the long-term air transport trends. This requires a qualified description of the respective data sources and the provision of search functions for these descriptions depending

on the user requirements. In addition to the "technical" parameters and data descriptions it is important to provide descriptions about the way data have been surveyed as well as on the purpose respectively the limits of application.

Given this evaluation MONITOR delivers an advanced and extended meta-data concept that gains its advantages from describing different kinds of data sources (statistical collections, scientific articles, etc.) in a very detailed manner and from different perspectives so that the value for different user groups can be estimated also from non-professionals.

3. <u>Identification of relevant data as input for the database</u>

The final selection of topics and data to be monitored and to be described by the introduced meta-data scheme was to a great extent accomplished by the Stakeholder Survey. The questionnaire asked for the specific views of possible consumers which external and internal factors they think should be monitored by the MONITOR project. The survey also included questions concerning which data are available for the respective stakeholders and which data is considered as reference. Based on the responses of the stakeholder survey, the project partners were therefore able to identify those parameters that should be regularly monitored with the help of adequate data sources.

The general criteria for the identification of relevant data as input for the meta-database were that the corresponding sources should allow:

- Monitoring of year-over-year changes in the air transport sector
- Long-term analyses of trends/developments of air transport as well as framework developments
- Providing a brief overview on short-term developments at the same time
- Utility for modeling and scenario creation/adaptation

In addition, the recommendations of the stakeholders (Advisory Committee members and survey participants) were collected. Especially their hints at gaps in the field of air transport and framework data and the estimation on the big challenges for the aviation sector for the next 30 years were taken into account to identify data fields of interest. With regard to the air transport sector these fields mainly covered the following issues:

- Traffic performance (number of movements, passenger volume, freight load etc.),
- Infrastructure (airport capacity, ATM, …),
- Technology (aircraft types, engine development, …),
- Environment (local and global emissions, noise, land use, …),
- Safety and Security (accident rates, incidents, …),
- Political framework (transport and infrastructure policy, environmental policy, competition policy, employment policy, …).

In addition, the following data fields with regard to the framework data were seen as mandatory in order to complete the long-term view on air transport trends:

- Demographic development (demographic growth rate, ageing structure, urbanisation, …),
- Economic situation (Development of GDP, foreign trade, competition framework, …),

- Energy availability (oil price development in particular)
- Ecological situation (climate change, environmental policy, natural catastrophes, …),
- Traffic development in general (mobility trends, competition between transport modes, …),
- Politics (centralisation versus decentralisation, regulation/deregulation, supra-national organisations, security, …).

First, it was important that the data should show some level of quality. This could either be secured in the form that the chosen data is not available for free and that a supplier guarantees a kind of reliability. The same held for the precondition that the data should be collected regularly by institutions or organisations which stand for reliability with their name or position in society.

Regarding the long-term and global horizon of the MONITOR project it was also regarded as important to focus mainly on data which covers a longer time horizon –may it be in the form of time series for historical data or in the form of forecast and scenario studies which provide a longer outlook into the future. Concerning further the geographic coverage, data for the whole world was classified as being important as well as data with a link to Europe, as MONITOR is an EU-funded project with a strategic focus on the EU.

A third criterion for the data selection was finally that a balance should be reached concerning the content of the data collection with regard to the database structure. Following this approach the idea was to collect a similar number of data and other sources for all of the eight data categories presented above.

Given all these requirements, the following data groups and types were seen as most important in the function to become part of the preliminary MONITOR database:

> 1. Official Statistics (from Statistical Offices or Intergovernmental Organisations such as UN, ICAO, FAA, EUROSTAT, …)
> 2. Data sources of relevant scientific institutions and organisations (e.g. universities, DIW – German Institute for Economic Research, …)
> 3. Statistics from known and established (industry) associations (e.g. IATA, ACI, AEA, …)
> 4. Data sources from established commercial suppliers (e.g. OAG Data, Sabre, …)

Given these criteria and the identified data fields of interest, a list of the data sources to describe was produced. For the air transport sector this list included preliminary about 70 different sources (data, documents, links, etc.) while for the data on external developments originally about 15 sources were foreseen. The following tables present an excerpt of these lists.

Content category	Titel	Publisher/Supplier
Aviation technology	ACARE Visions	ACARE
Airport and ATM	ACI Airport Economy Survey	ACI
Airport and ATM	ACI Annual World Airport Traffic Report (WATR)	ACI
Air transport demand	ADV Fluggastbefragung	DLR
Air transport demand	Aerospace Facts and Figures	Aerospace Industries Association
Airport and ATM	Air4Casts	Air4casts Limited
Aviation technology	Airbus Global Market Forecast	Airbus
Aviation technology	Aircraft Analytical System	Flightglobal
Airlines	Ascend Online Fleets	Ascend
Environmental Issues	Boeing Web Site on Airport Noise and Emissions Regulations	Boeing
Aviation technology	Bombardier Aircraft Market Forecast	Bombardier
Air transport demand	CAA Surveys	CAA
Air transport demand	CONSAVE	DLR
Aviation technology	EASA annual safety review	EASA
Airport and ATM	Eurocontrol DAIO - Departures, Arrivals, Internals and Overflights	Eurocontrol (Statfor)
Airport and ATM	Eurocontrol Forecasts	Eurocontrol (Statfor)
Air transport demand	Eurostat Air Transport Statistics	Eurostat
Airport and ATM	FAA Aerospace Forecast	FAA
Airlines	IATA World of Air Transport Statistics (WATS)	IATA
Airlines	ICAO Air Carriers - Personnel	ATI
Air transport demand	ICAO Air Carriers - Traffic	ATI
Air transport demand	ICAO Outlook for Air Transport	ICAO
Airlines	OAG Schedules Data	OAG
Airport and ATM	Perforemance Review Report (PRR)	Eurocontrol

Table 1: List of data sources concerning the air transport sector

Framework category	Titel	Publisher/Supplier
Population		
Population	Demographic Yearbook	United Nations Statistics Division
Population	IIASA Population database	IIASA
Economy		
Economy	World Development Indicators (WDI)	The World Bank Group
Economy	OECD Economic Outlook	OECD
Energy		
Energy	BP Statistical review of world energy	BP
Energy	World energy outlook	International Energy Agency (IEA)
Emission development in general		
Emission development in general	Emissions Database for Global Atmospheric Research (EDGAR)	EC JRC IES CCU
Emission development in general	Carbon dioxide information analysis tool (CAIT)	World Resources Institute (WRI)
Integrated Assessment Scenario		
Emission development in general	Special Report on Emissions Scenarios (SRES)	IPCC
Population , gdp, energy, emissions	IPCC RCP (Reference concentration pathways, includes various modells, including IMAGE, MESSAGE, AIM and others)	IPCC, IIASA
Further sources with either non-global coverage or additional framework categories		
Mobility trends in general	Mobility 2030	World Business Council of Sustainable Development
Population	Global population data	Landscan
	OECD Factbook on Economic, Environmental and Social Statistics	OECD

Table 2: List of data sources on external developments

With regard to the fact that the monitoring of aviation trends was foreseen and is still intended to be a regular and continued activity, it has to be stressed that the above mentioned data sources only represent a preliminary data collection. Many more important sources were already identified but could not be described due to time limits and to the fact that the availability and actuality of some sources also changes over time.

4. Elaboration of the data collection

After the build-up of the database structure and the meta-data concept as well as the data selection process, the concrete data collection was. This included firstly the prioritisation of the data sources which should be described and the elaboration of a "Meta-data Collection Sheet.

312th WCTR, July 15-18, 2013 – Rio, Brazil

For the establishment of the data collection a data storage system had to be chosen which should fulfil at least the following requirements:

- Use and maintenance should require minimum effort, but simultaneously provide maximum efficiency.
- The system should serve the different needs of several users from specific target groups (integrated air traffic modelling) as well as allow for external use by means of the internet.
- Safety aspects have to be considered, i.e. the restricted use option is mandatory.
- Continuous maintenance and updating should be assured.
- Central task of the database is meta-data archiving (completed assessments or collected documentations are only collected in a second step).
- Meta-data information should be centrally stored in an easily accessible way in order to avoid multiple or individual collections.

Given these requirements, the final decision for an adequate data storage and management system led to the choice of the "DataFinder", a DLR-internally developed software that was capable of integrating the MONITOR data collection in an adequate way.

The following key findings are a result of the survey:

Key findings and comments from the survey:

- Information on air transport policy and market development in the air transport sector are most important for the aviation experts in the air transport internal field.

- With regard to the air transport external field, environmental policy and energy availability and use are seen as most important information.

- The development of passenger demand, the capacity situation of airports and the economic situation are regarded as the most influencing drivers for air transport development in the long-term.

- The most important challenge for the next 30 years with regard to aviation are in the major opinion of the respondents the environmental issues, followed by energy availability and the capacity situation at airports.

- Generally, of minor importance are the political situation and socio-economic factors (migration, tourism, human behaviour etc.). The majority of the respondents do not declare that they see those aspects as important air transport drivers nor is this the most important information source they are interested in or working with.

- With regard to the data needs of the asked experts, the majority wishes short, compacted and up-to-date information on on-going trends and challenges.

- The data used or wished by them should have a good quality as it is mainly used for strategic decision-making and own research work.

Table 3: Key findings and comments from the MONITOR Stakeholder Survey

5. Integration in the MONITOR online portal

After the meta-data and the adequate data sources, in case of availability, had been stored in the database of the "DataFinder", the great challenge was to plan the integration of this information in the MONITOR online portal. From the beginning of the project it became especially clear, that IPR issues would cause a problem with regard to the public access to the MONITOR results, as many data sources which were regarded as strategically important could not be shown with free access as they were linked with costs and/or distribution was permitted.

Therefore, access was limited to the MONITOR data collection with regard to the original data sources. This was not seen as disadvantage, as the detailed meta-data descriptions contributed already to a very detailed impression on each data source. This means that even if the original source cannot be seen by users, the meta-data delivers sufficient information to estimate if a data source is of value for the special interest of a user and if it is worth to contact the data supplier for access to the data. This way the MONITOR online portal was constructed as working as a first central contact point for data-interested users who would like to gain an overview and deeper insight to specialised data sources.

CONCLUSION

The achievement of the MONITOR project was in this context to elaborate a consistent, but also upgradable and flexible monitoring system which brings data and statistics in connection with quantitative analyses (MONITOR Aviation Scenarios) and qualitative analyses (MONITOR Indicator Set). Each of these pillars was built iteratively step by step and stands in connection to the other pillars. The MONITOR meta-database is the reliable base for the resulting analyses, while the indicators serve the purpose to investigate past and current trends in the aviation sector and to draw conclusions from this. Internal and external drivers are included in all of the three monitoring pillars, which guarantees that different perspectives and the most important topics are covered.

Due to its long-term and global focus the outcome of the MONITOR project is of strategic importance and applicable to a wide range of research questions and cases.

Given these advantages, the current system forms a stable base for a further development within the next years. Within this time horizon, a rather short-term and a rather long-term development vision have to be distinguished.

It can finally be concluded that the MONITOR project was successful as a pilot study which dealt with the build-up of a flexible and upgradeable system that is capable of a permanent scanning and assessing of trends with relevance for the aviation sector. The broad focus of the current monitoring system means at the same time that many important aspects from different perspectives are covered. The risk to narrow the view on the complex and dynamic air transport sector is avoided this way. However, it has to be kept in mind that the described monitoring system is just a starting point for a continuous trend and risk assessment, as the system only keeps its strength, attractiveness and usefulness if the content of the system is regularly updated, extended and adapted to new requirements.

REFERENCES

Reports / Studies:

Berghof, R., Hepting, M., Wittmer, A., Bilacz, Z., Hoolhorst, A., Schulz, N., Leipold, A., Guraly, R., Kokus, P., Kral, N., Middel, J., Schmitt, A., 2012, Monitor – Monitoring System of the development of Global Aviation, Final Report, Seventh Framework Programme Aeronautics – FP7-AAT-2008-RTD-1, Project No. 233999, Brussels: March 2012. http://www.monitor-project.eu/

CONSAVE 2050, 2005, Constrained Scenarios on Aviation and Emissions, funded by the European Commission - GROWTH Project GMA2-2001-52065, http://www.dlr.de/consave/index.htm.

ACARE, Advisory Council for Aviation Research and Innovation in Europe, http://www.acare4europe.org/.

Eurocontrol, 2010, Eurocontrol Long Term Forecast 2010 – 2030, https://www.eurocontrol.int/sites/default/files/content/documents/official-documents/forecasts/long-term-forecast-2010-2030.pdf

Cleans Sky Europe, JTI Clean Sky Technology Evaluator, http://www.cleansky.eu/

Databases:

Data sources concerning the air transport sector

Content category	Titel	Publisher/Supplier
Aviation technology	ACARE Visions	ACARE
Airport and ATM	ACI Airport Economy Survey	ACI
Airport and ATM	ACI Annual World Airport Traffic Report (WATR)	ACI
Air transport demand	ADV Fluggastbefragung	DLR
Air transport demand	Aerospace Facts and Figures	Aerospace Industries Association
Airport and ATM	Air4Casts	Air4casts Limited
Aviation technology	Airbus Global Market Forecast	Airbus
Aviation technology	Aircraft Analytical System	Flightglobal
Airlines	Ascend Online Fleets	Ascend
Environmental Issues	Boeing Web Site on Airport Noise and Emissions Regulations	Boeing
Aviation technology	Bombardier Aircraft Market Forecast	Bombardier
Air transport demand	CAA Surveys	CAA
Air transport demand	CONSAVE	DLR
Aviation technology	EASA annual safety review	EASA
Airport and ATM	Eurocontrol DAIO - Departures, Arrivals, Internals and Overflights	Eurocontrol (Statfor)
Airport and ATM	Eurocontrol Forecasts	Eurocontrol (Statfor)
Air transport demand	Eurostat Air Transport Statistics	Eurostat
Airport and ATM	FAA Aerospace Forecast	FAA
Airlines	IATA World of Air Transport Statistics (WATS)	IATA
Airlines	ICAO Air Carriers - Personnel	ATI
Air transport demand	ICAO Air Carriers - Traffic	ATI
Air transport demand	ICAO Outlook for Air Transport	ICAO
Airlines	OAG Schedules Data	OAG
Airport and ATM	Performence Review Report (PRR)	Eurocontrol

Data sources on external developments:

Framework category	Titel	Publisher/Supplier
Population		
Population	Demographic Yearbook	United Nations Statistics Division
Population	IIASA Population database	IIASA
Economy		
Economy	World Development Indicators (WDI)	The World Bank Group
Economy	OECD Economic Outlook	OECD
Energy		
Energy	BP Statistical review of world energy	BP
Energy	World energy outlook	International Energy Agency (IEA)
Emission development in general		
Emission development in general	Emissions Database for Global Atmospheric Research (EDGAR)	EC JRC IES CCU
Emission development in general	Carbon dioxide information analysis tool (CAIT)	World Resources Institute (WRI)
Integrated Assessment Scenario		
Emission development in general	Special Report on Emissions Scenarios (SRES)	IPCC
Population , gdp, energy, emissions	IPCC RCP (Reference concentration pathways, includes various modells, including IMAGE, MESSAGE, AIM and others)	IPCC, IIASA
Further sources with either non-global coverage or additional framework categories		
Mobility trends in general	Mobility 2030	World Business Council of Sustainable Development
Population	Global population data	Landscan
	OECD Factbook on Economic, Environmental and Social Statistics	OECD

Expert organizations:

Organisation	Field of expertise
ACI Europe	Airports
EASA	Regulation
Siemens AG	Transport Scenarios
IIASA	Transport Scenarios
Lufthansa AG	Airlines
Siemens AG	Transport Scenarios
FAA	Regulation
EUROCONTROL STATFOR	Scenarios/ Aviation Forecasts
IATA	Airlines
IATA	Airlines
Airbus	Manufacturer
Swiss FOCA/ BAZL	Regulation

ACKNOWLEDGEMENTS