Long-term performance of the global air transport system in special consideration of sustainability issues

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Within the last years, the area of conflict between the continuous growth of the air transport sector and the negative effects on the environment like air transport's contribution to GHG emissions or the burden of noise in airport surroundings became more and more evident. An especial challenge consists of the partly diverging interests among the stakeholders in this development (e.g. airlines, airports, ATM, passengers, supplier industry, airport residents and environmental associations). Facing these conditions, the challenging task for politics is to balance these interests, to reach compromises and to elaborate measures for a sustainable development in general and in regard of the functionality of the air transport system. Therefore, a well-founded analysis with regard to the complex nature of the air transport system, its dimensions, its drivers and its actors is needed. Addressing these requirements, the Institute of Air Transport and Airport Research has developed an indicator system which is capable of showing general trend lines as starting basis for a continuous monitoring of the air transport system development in consideration of sustainability issues.

This system is signified by two types of indicators which allow in connection a holistic analysis of the long-term developments in global air transport with a focus of more than the last twenty years. The first category of these indicators is represented by so-called Performance Indicators (PIs) which mainly deal with the question how efficient the air transport system works with regard to its essential function: the fast transport of passengers and goods. For this purpose more than 25 indicators were developed that allow altogether a detailed overview of the traffic and financial performance of global airlines and airports as some of the most important actors in the air transport supply chain. A special priority was in this context also given to the characteristics of the global fleet development as one essential element for estimating the state-of-the-art with regard to the technological development in the air transport sector. As second indicator category, the Sustainable Development Indicators (SDIs) were introduced as they allow to go one step further by investigating the relation between air transport internal and external developments and to show how they influence each other with regard to the economic, ecological and social objectives that are important in reference to a sustainability approach. In connection with this task, further 15 single indicators were developed.

The strength by the structure of this indicator system is that it allows a continuous analysis of on-going important trends in the air transport sector by a discussion of the separate indicators but also by identifying interdependencies between them what facilitates putting trends in an overall context. For example, the correlation between the GDP development per capita in different world regions and the number of trips per capita can be investigated this way. Summing up this example, the developed indicator system provides also a good starting point to discuss the development of the air transport sector in contrast to other transport modes and further sectors against the background of general sustainability goals from the field of politics.

The indicator system is also already part of an advanced monitoring system for the development of international air transport which can be found under www.airtransport-monitor.eu.

1. Introduction

The contradiction between the continuous growth of the air transport sector and the negative effects on the environment has gained in importance within the last years and is supposed to be evident in future as well. Facing the diverging interests of different stakeholders like airlines, airports, passengers and airport residents, ATM, supplier industry or environmental associations, the future key issue will be how the expected challenges of a growing air transport system can cope with the needs for an efficient and sustainable transport system which is able to satisfy the future demand in the same manner as today and in high quality. It is a challenging task for politics to balance these interests, to reach compromises and to elaborate measures for a sustainable development in general and in regard of the functionality of the air transport system. Especially economic growth and the ecologically negative effects of flying seem to conflict with each other. At the same time, social aspects as third pillar of sustainability have to be considered in order to create a future air transport system that is capable of offering the needed degree of connectivity for affordable prices by guaranteeing the highest possible safety standards at the same time. Besides these sustainability requirements, the air transport system of the future has, however, to be efficient and economically successful which means that it has to fulfill its basic transport function and has to offer fast, reliable, cost-efficient and punctual transport opportunities.

Before the development of concrete policies, regulations or planning strategies for the whole air transport system, it is important to monitor and understand the long-term trends of global air transport, to investigate on-going changes and to expose the complex interdependencies between different system components of the overall air transport system and the impact through framework developments outside the air transport sector.

For this purpose, with the project MONITOR (Monitoring System of the Development of Global Aviation), which was funded in the 7th Framework Programme of the European Union, a permanent monitoring system for the development of the global air transport system has been derived. This system is based on three pillars which are summarised in the following figure.

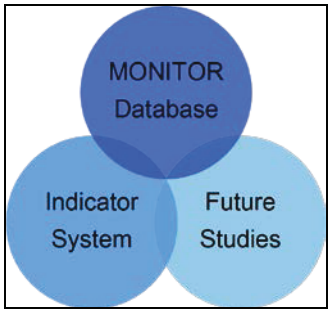

Figure 1: Overview of the monitoring system of MONITOR

The (meta-) database offers detailed information on air transport relevant sources with regard to development statistics and analyses, which deal with air transport internal topics but cover also relevant framework developments. The section of future studies provides an overview on scenarios and assumptions with regard to the long-term air transport development in order to address the progress in the air transport sector and hint at new trends. Besides of the air transport database and the future studies, especially the indicators form an essential part of this system as they were developed in the project context in order to provide a basis for the assessment of the overall global air transport development in consideration of sustainability issues. Further information on that advanced monitoring system can be found under www.airtransport-monitor.eu.

The present paper will point out the indicator system of MONITOR as well as the ACARE Flightpath 2050 goals in order to make a first assessment of the development of the global air transport system with regard to the described sustainability goals.

2. Assessment of air transport developments by an indicator system

The provision of short and compacted information for special topics can be supported and provided by the use of indicators, likewise for the analysis of the air transport sector. Indicators can therefore make a contribution to the description and evaluation of the air transport development with regard to its ecological, economic and social impact on different geographic levels (sustainability approach). A fast and precise overview of complex situations and the comparison of changes and developments over time and between different

indicators is another objective that can be supported by the use of concentrated information. As an outcome, requirements for the assessment of the air transport system, its respective individual components (key actors, key drivers) and their interactions can be drawn where possible, so that the indicators system may function as an early warning system (with regard to system analysis and typical use cases).

An indicator approach allows assessing the developments of different systems on various geographic and temporal levels and with regard to the economical, ecological and societal column of sustainability. To describe manifold facets of the air transport system, its drivers and limitations, a set of functional and consistent indicators can be useful and may serve the purpose to measure target precision and to evaluate if the real air transport development with its diverse components, if the indicators are compared to existing political goals and initiatives. As a further step, such analyses can also be used to make suggestions for improvements – either with regard to the political level or with regard to the air transport system internal point of view.

Before the description of the indicator system of MONITOR, some general ideas on indicator systems, which are currently in operation and e.g. used by scientific research should be made, as systems are complex and are based on various concepts. Besides their geographical and temporal diversity ranges the main difference of those systems is their basic function which allows differing between Performance Indicators (PIs) and Sustainable Development Indicators (SDIs). PIs are concentrated on the concrete performance of an individual system and are mainly defined from an internal focus within the air transport system resulting from the involved actors. SDIs are defined from an outstanding perspective with the special function (in this context) to describe developments with regard to general sustainability.

By addressing the complexity of developments at the same time, the MONITOR indicators are in this context understood as a measure which consists of two or more separate figures. Thus, an indicator regards several developments in relation to each other and investigates the significance of these developments for the overall condition of the air transport system at any regarded point of time. According to this definition and function of PIs and SDIs the MONITOR indicator system includes 5 performance indicator categories with an internal focus concentrating on airlines and airports in the first instance and 3 sustainable development indicator categories with together 42 single indicators which cover – as far as data was available – the air transport system and relevant framework developments to a great extent. The MONITOR indicator system puts a special focus on many aspects of the air transport system development and is therefore combinable with the existing different targets for the sector development so that interrelations between different trends can easily be identified this way. Figure 2 below provides a general overview of this system.

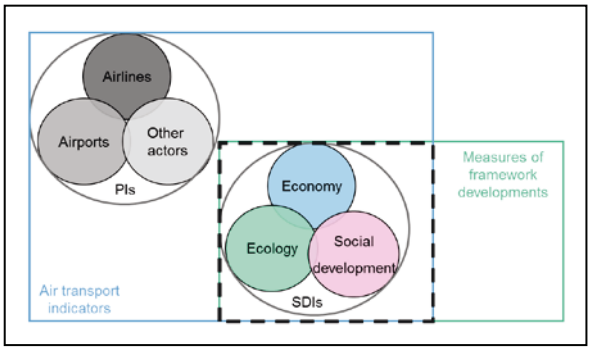

Figure 2: Overview of the MONITOR indicator system

As an example for the description of performance indicators of air transport developments, a special emphasis was given to the characteristics of the global fleet development as one essential element for estimating the state-of-the-art with regard to the technological development in the air transport sector (cf. chapter 4.1). As in some cases the data availability was limited, some aspects could not be represented in the same manner as others as for example in the field of ecological SDIs aggregated and global data for the long-term with regard to noise or local air quality could not be found. The chosen system structure allows nevertheless to easily integrating further indicators if data availability changes in future.

2.1 Performance indicators

Similar concepts to the MONITOR indicator system are used as well within the air transport sector by public institutions and organisations

such as the Performance Review Commission from EUROCONTROL in order to monitor the air transport development from the point of view of Air Traffic Management (Performance Review Commission, 2012). Indicator systems are an indispensable basis for the monitoring and assessment of the air transport system, although the focus of PIs – or Key Performance Indicators (KPIs) as they are often referred to – has a narrow interpretation. For example, on company level they are e.g. applied to evaluate the economic success of business activities with regard to the achievement of self-imposed goals.

The following figure shows the performance indicators used by MONITOR taking into account the above considerations.

Various PIs in this concept are conceivable for investigating the global air transport system performance. For example, financial figures can on the one hand be considered on an individual company or on an aggregated level. This approach can be further distinguished according to the circle of actors like airlines, airports, ATM or else. On the other hand, also other key figures concerning the basic transport function of

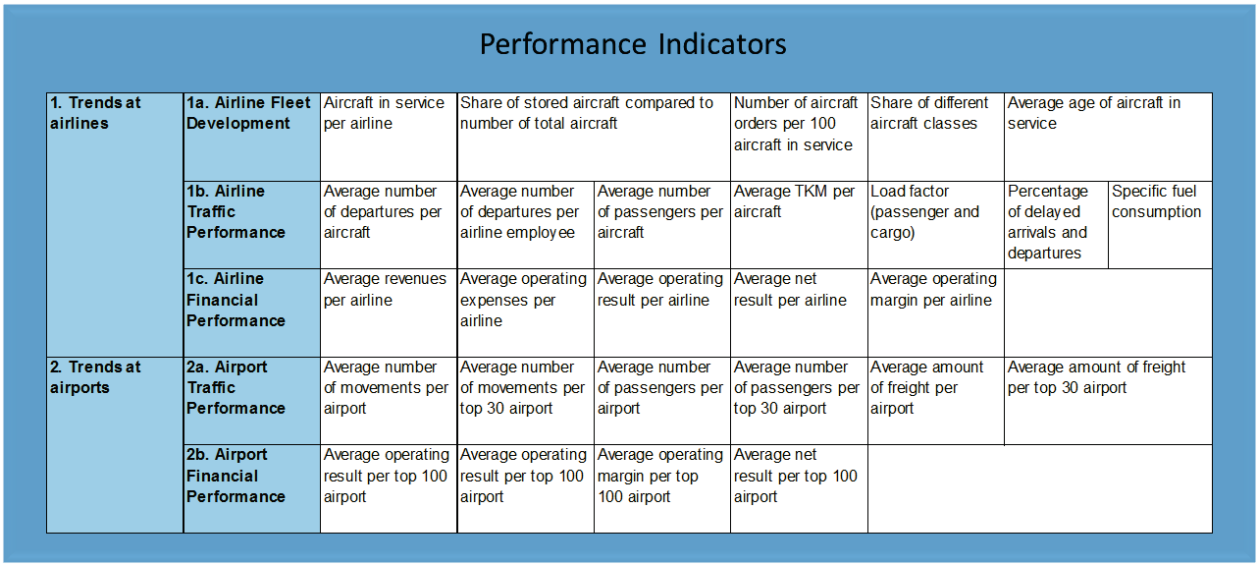

Figure 3: Performance indicators of MONITOR

The intention of PIs is to describe the air transport development on an aggregated level and to investigate how it fulfilled its basic function of offering fast, reliable and manifold transport opportunities within the recent years up to now. The research question which shall be answered in this context is how efficient the air transport system acts in order to fulfil these requirements. The air transport sector will from this perspective be regarded as a system in itself and only system-internal trends will be considered. The PIs used by MONITOR contain a set of key figures, which provide the planning, control and management of various operations and processes. There will be shown manifold application ranges for PIs and the respective figures under consideration. As the shown PIs describe the only internal view of the air transport system, the interactions between the air transport system and other systems or external dimensions are part of the SDI concept.

aviation (like flight movements, passenger and freight volumes etc.) as well as other performance rates (punctuality etc.) are conceivable.

2.2 Sustainable development indicators

The concept of sustainability, which aims at preserving the current living conditions in favour of the following generation (according to the Brundtland-Report) constitutes the basis for the Sustainable Development Indicators. Sustainability is a universal concept which means that it can only be regarded as a whole and has to be understood and realised as common task for politics, industry and society. A responsible use of the available resources and a respectively focused long-term orientation on the sustainability columns economy, environment and society are preconditioned. The development of the air transport sector can therefore in this context not be regarded solely and has to observe the interrelation between air transport system developments in relation to

external developments with high impacts like population or economic growth.

Three different types of SDIs can be distinguished according to the three pillars of sustainability. SDIs within the economic dimension mainly comprise economic key figures of air transport as they support the investigation of the linkage of the global economy with the air transport system to the sustainability postulate. Examples for SDIs in the economic area are the development of flights or freight tonne-kilometres in relation to global GDP development. Subdivided to a world regional level, these analyses can help to assess the development of transport opportunities in relation to the economic development and to compare and evaluate the status of different world regions in this field.

of the air transport system is also of societal importance. Since the air transport activities contribute to wealth on the national economy level, this has an effect on the dimension society as well. Environmental issues (and associated indicators) are closely related to the state of health of a population which again leads to social issues. Similar relations exist also between the economic and the environmental domain, although they are not discussed here. With regard to all three dimensions of sustainability it has furthermore to be considered that developments in the air transport sector and framework developments can influence each other – independently of the regarded pillar of sustainability. The following table gives an overview of the MONITOR SDI's, taking into account all three sectors of sustainability.

Sustainable Development Indicators

3. Indicators on economic aspects of air transport development	Development of freight tonne kilometres per inhabitant		Economic specific flight development		Economic specific freight tonne kilometre development		
4. Indicators on ecological aspects of air transport development	Development of absolute CO_2 emissions	Air transport emissions share in total CO_2 emissions	Percentage change of overall and air transport CO_2 emissions	Index development of overall and air transport related CO_2 emissions	CO_2 emissions from air transport per 1 mill. Pax	CO_2 emissions from air transport per 1 mill. Pkm	CO_2 emissions from air transport per 1 mill. Tkm
5. Indicators on social aspects of air transport development (aspects of transport function)	Number of departures per 1,000 inhabitants	Number of passengers per 1,000 inhabitants	Number of passengers per 1 million US$ GDP	Fatal accidents per 1 million flights	Passengers killed per 1 billion RPKs	Average time of travel between selected airports (Connectivity)	

Figure 4: Sustainable development indicators of MONITOR

The environmental SDIs serve the description of the air transport system from an ecological point of view under the aspect of sustainability. As an example, the specific indicators in this field can cover the amount of emitted CO_2 emissions in air transport in relation to the overall amount of emitted CO_2 emissions over the years. Taking additionally the general air transport development into account, this indicator can even analyse if a decoupling between transport growth and emissions development has happened or not. Currently, data limitations constrain the analysis of noise or local air quality but can easily be integrated into the MONITOR indicator system in future.

Social issues as third pillar of sustainbility represent at last a special challenge (Bundesamt für Zivilluftfahrt, 2008), as the thresholds between environment and economy are floating and the social pillar of sustainability is hardly separable from these two pillars. For example, an indicator judging the economic performance

3. Air transport sector specific strategy goals with special consideration of Flightpath 2050

General strategic development goals have in the following context to be regarded as being only relevant for the air transport or the transport sector as higher dimension. In contrast, as sustainability is a universal concept, sustainable development goals cover always all industry sectors, as well as the fields of politics and society. Due to the fact that a sustainable development can only be reached if every individual acts according to the postulate that his or her lifestyle may not limit the fulfillment of the needs of the next generation, the achievement of a sustainable development means therefore always to follow an adapted, consistent and universal strategy that considers interrelations

and target conflicts between different actors and is balanced in order to be efficient.
In the first step an overview on sustainable development goals in regard to air transport are given. In the second part of this chapter important air transport related strategy goals are introduced. And in the third step the Flightpath 2050 goals are discussed. These goals are analyzed in more detail in chapter 4.

3.1 Overview on sustainable development goals

The UN as a supranational organisation has the legitimation to formulate and enforce sustainable development goals which have to be (according to the definition of sustainability) go beyond the air transport system and therefore have to come from a universal perspective, respecting the overall use of resources and the dimensions of politics, industry and society. A first view on the UN agenda nevertheless shows that concrete goals which are relevant for the transport sector are hardly available and the more general goals are not specified enough. Especially the Millennium Development Goals have a focus that does not fit to extract handling perspectives for the air transport sector (UN, 2001). The only suitable general goal in this set of goals is goal no. 7 which is dedicated to the purpose to ensure environmental sustainability.
Slightly more concrete goals are included in the final resolution of the Rio+20 conference (UN, 2012), where the essential importance of transport is addressed to enforce economic development and to provide mobility opportunities:

(1) The importance of the efficient movement of people and goods
(2) The relevance of access to environmentally sound, safe and affordable transportation as a means to improve social equity, health, resilience of cities, urban-rural linkages and productivity of rural areas
(3) Road safety as part of the UN's efforts to achieve a sustainable development
(4) Support for the development of sustainable transport systems, including energy-efficient multimodal transport systems, notably public mass transportation systems, clean fuels and vehicles, as well as improved transportation systems in rural areas
(5) The need to promote an integrated approach to policymaking at the national, regional and local levels
(6) The development needs of landlocked and transit developing countries

Taking all these statements into account, all points with exception of no. 3 are important and relevant for the air transport sector. Although, the UN is very general in its position and regards the transport sector as a whole, it covers all three pillars of sustainability.

3.2 Air transport specific strategy goals in general

The strategic development goals, which are discussed in the following, have a narrower focus than the sustainable development goals although they can be influenced by the last mentioned ones. They have in common that they were mainly defined by industry associations or political bodies and organisations for the aviation sector without addressing the development postulates with regard to other sectors. Additionally, framework developments which can influence the air transport sector's future perspectives are also only partly considered by these actors. In dependence from the relevant actor, the chosen goals are not always neutral and originate from strategic considerations in order to strengthen the own position, so that they have to be interpreted carefully. Strategic development goals play a notable role in designing an efficient air transport system in itself and in order to bring aviation in the right position to contribute to an overall sustainable development.

As one example, the ICAO as United Nations specialised agency and global organisation with legitimation to set up international standards for civil aviation have set up strategic objectives that have to be mentioned as most representative goals of the organisation (ICAO, 2013). The current strategic objectives for the period 2011-2013 include the following specifications (ibid.):

(1) Safety: Enhance global civil aviation safety
(2) Security: Enhance global civil aviation security
(3) Environmental Protection and Sustainable Development of Air Transport: Foster harmonized and economically viable development of international civil aviation that does not unduly harm the environment

It can be concluded that these objectives are suitable for the further analysis on the basis of

the indicator approach mentioned above, as the current set of indicators covers the aspects of safety and environmental protection and sustainable development of air transport. These topics are addressed by the existing indicators which are currently in use.

Partly similar targets as those of ICAO are also promoted by IATA, the world's leading airline association. During 2012 the responsible IATA Board committed itself to the following priorities and targets, which are cited here in short (IATA, 2012):

(1) Safety: Improve global safety, especially in Africa
(2) Security: Improve security checkpoints
(3) Airline revenues: Manage airline revenues securely and efficiently
(4) Value chains: Re-balance the value chains, improve airline revenues, and reduce costs
(5) Environment: Protect the industry's ability to grow in a sustainable manner
(6) Regulatory: Protect members from burdensome regulation
(7) Industry costs and customer service: Create value, reduce industry costs, and improve customer service

The comparison to the ICAO goals shows, however, that IATA's goals are much more specified and have the needs of their members in focus. Especially the objectives 3, 4 and 7 are mainly in direct linkage to IATA tools and processes and have a more indirect impact on the overall development of the global air transport system. Only in conjunction with resulting economic effects from improvements with regard to these target fields they should be taken into account.
As another example for strategic goals the long-term vision Flightpath 2050 can be mentioned but will be considered especially in the following chapter as they are of special relevance for the assessment of the MONITOR indicator results.

3.3 Flightpath 2050 goals as example for sector specific strategy goals

The European air transport system will be faced with new challenges in the near future, addressing its competitiveness, performance and sustainability. With new and emerging competitors on the market and global challenges like reformable financial systems and climate change, Europe must ensure to keep its competitiveness in world air transport markets by increasing technological research by keeping as well in mind the sustainability of future developments. Therefore, the European commission has invented a high level Group to develop a vision for Europe's aviation system[1], inviting stakeholders of European aviation like aeronautics industry and management, airports, airlines and research communities. The ensuing initiative of the Advisory Council for Aviation Research and Innovation in Europe (ACARE), a group of key stakeholders from the European aviation industry and research, which works on behalf of the European Union, will be regarded in the following. Although they come from a European perspective, their vision for aviation up to 2050 is relevant for the whole sector as air transport is a global business and ACARE considers global trends as well (ACARE, 2012).

The main goal that has been identified for the future is the leadership of Europe's aviation community in sustainable aviation products and services by still meeting the needs of EU residents and society. Following this, five strategic goals have been implemented:

(1) Meeting societal and market needs
Air transport in 2050 is part of an intermodal system aiming at the satisfaction of customers. Multiple choices for passengers guarantee a fast and affordable transport on schedule regardless of weather conditions. Air transport will be supported by an efficient air traffic management and a coherent ground infrastructure connecting other transport modes.

(2) Maintaining and extending industrial leadership
It is assumed for 2050 that Europe has consolidated its position as a world leader with a competitive, sustainable and innovative aviation industry, which means a share of 40% of the global market. Cutting edge and streamlined designs, manufacturing and system integration are the basis for an excellent innovation process as well as decreased development costs.

(3) Protecting the environment and the energy supply
The high aims for the environmental sector include a fully understanding of the atmospheric process, allowing to develop technologies and procedures to reduce CO_2, noise and NOx

[1] European Commission: Flightpath 2050 – Europe's Vision for Aviation, 2011.

emissions up to significant levels of more than 65%. Recyclable air vehicles, emission-free taxiing of aircraft, alternative fuels and emission trading scenes are further parts of the future environmental standards.

(4) Ensuring safety and security
Incomparable levels for safety (accident reduction of 80%) and security (security screening without intervention) with existing and new types should be reached by a holistic system approach to aviation's safety, supported by safety management and certification processes as well as seamless security for passengers and high-level security standards for vehicles. Data security and privacy preservation are high aims as well.

(5) Prioritising research, testing capabilities and education
The strengthening of European research begins on the students level with engaging academic research and needs of industry, is continued within the definition of research strategies by all stakeholders and leads to multi-disciplinary technology cluster networks, that are based on collaboration between industry, universities and research institutes.

To a great extent these goals are in line with the above mentioned objectives of ICAO and IATA, although some refer rather to the European level and have a more industry-oriented focus. As there is a linkage to the social dimension of sustainability and the addressing of market needs allows to establish a further connection to the performance indicators of the MONITOR indicator system, the Flightpath 2050 goals will be set in relation to the MONITOR indicator results in the following.

4. The assessment of the current air transport development

4.1 Analysis of trends in the air transport development

The evaluation of the air transport development of the past will be exemplary described by selected indicators that were chosen from the MONITOR indicator set. The indicators deal with different components of the air transport system or with system internal and external components. The group of Performance Indicators, which cover the system internal point of view, is exemplary described by the specific fuel consumption and productivity. The Sustainable Development Indicators are represened by the indicators of mobility, accidents and emissions that reflect air transport developments with a superior meaning for the overall sustainability. The chosen indicator examples therefore allow a short but comprehensive evaluation of air transport trends.

As far as data was available, the indicators show the period from 1990 to 2011 to have a long-term view which enables the recognition of clear trends. With regard to a better comparison they were indexed in reference to the year 1990 and merged in figure 5.

The indicator for indexed productivity (generally measured in departures of all IATA airlines per IATA airline employee) as example for the trends at airlines shows a rising trend curve as the productivity could be enhanced between the years 1990 and 2011 by about 37%. This means that less personnel was needed over the years in order to realise the same amount of traffic which is given in departures. The interpretations of the reasons of this productivity increase has to be made carefully as it could be the case that some airlines have outsourced their personnel which is then not counted in the IATA statistics anymore. In addition, it is probable that especially through the rise of low-cost carriers and their tendency to operate shorter routes, flight legs have become shorter over time and thus, each employee can work more flight legs. That is why the observed trend should not be over-estimated.

The indicator for the specific fuel consumption (representing trends at airlines) is a further performance indicator and can be classified as indicator for a development, to which the technology development of the global aircraft fleet has an important influence. The indicator development expressed by the graph in figure 5 shows in general a positive tendency. Between 1990 and 2008, the period for which data was available from the Emissions Database for Global Atmospheric Research (EDGAR), the specific fuel consumption could be reduced by nearly 40% what remarks a considerable decrease.

As the indicator for the specific fuel consumption has to be regarded in context with the following indicator for the overall CO_2 emissions from air transport, the course of the corresponding curve

of this SDI for the environmental dimension shows that within the same time the overall CO_2 emissions grew by approximately more than 30% caused by increased traffic. This development demonstrates that the decoupling of transport growth and its negative impacts with regard to the environment was obviously not so successful as it is desired.

in general a continuous downward trend is visible.

The last indicator in the presented set deals with mobility (measured in the number of passengers per 1,000 inhabitants) and investigates the degree of air transport usage in relation to the global population development. Mobility is in this

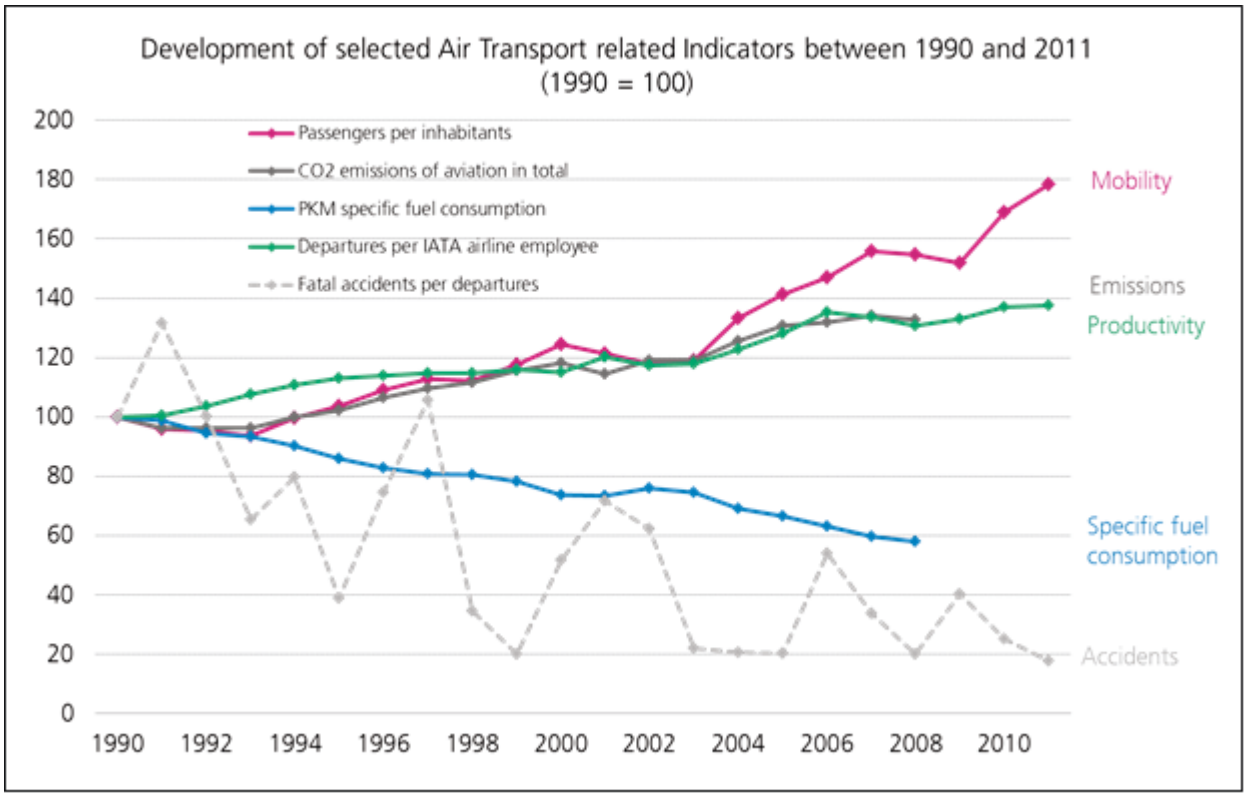

Figure 5: Selected air transport indicators and past development of the air transport system

The fourth indicator in the given figure deals with the development of fatal accidents per departures and was extracted from IATA statistics. It belongs to the social dimension of SDIs as safety means to increase the protection of human life and is one of the high-priority targets of nearly all investigated institutions and organisations. With regard to its statistical expressiveness, it has first to be said that safety is hard to measure. Drawing resilient conclusions from observed curve shapes remains for this reason a difficult task given the fact that the number of fatal accidents is a highly volatile indicator due to the unpredictability of accidents. Nevertheless, the development of more than 20 years, which is shown above, carefully indicates an improvement of safety as

context also a core aspect of the social dimension of SDIs as it shows to which extent the society has access to the air transport system and can profit from the global network and the degree of connectivity this network offers. The concrete indicator development which is expressed in the graph above, shows a considerable increase in the number of global passengers in relation to the world population as the indicator reflects a growth by more than 75% over the last 20 years.

4.2 First discussion of Flightpath 2050 goals by usage of indicators

In the following the results of the MONITOR indicators will be discussed with regard to the goals of Flightpath 2050 as both shown in the previous chapters in a qualitative way (see figure 6). This comparison will be drawn to identify the overall sustainable development of the global air

transport system by general sustainability goals. Some constraints of the assessment by the Flightpath goals might appear as these goals a have an European focus and imply, as they represent a highly ambitious vision, in some cases a more extensive and comprehensive view than the specific topic and sections used within the MONITOR indicators although those have a global focus. Nevertheless, as the Flightpath 2050 goals primarily deal with the aviation sector it will be attempt to draw conclusions for the development tendencies for the air transport system.
As an introduction, the following table shows the development tendencies over the last 20 years by comparison of the specific MONITOR indicators introduced in chapter 4.1 and the Flightpath goals of chapter 3.3.

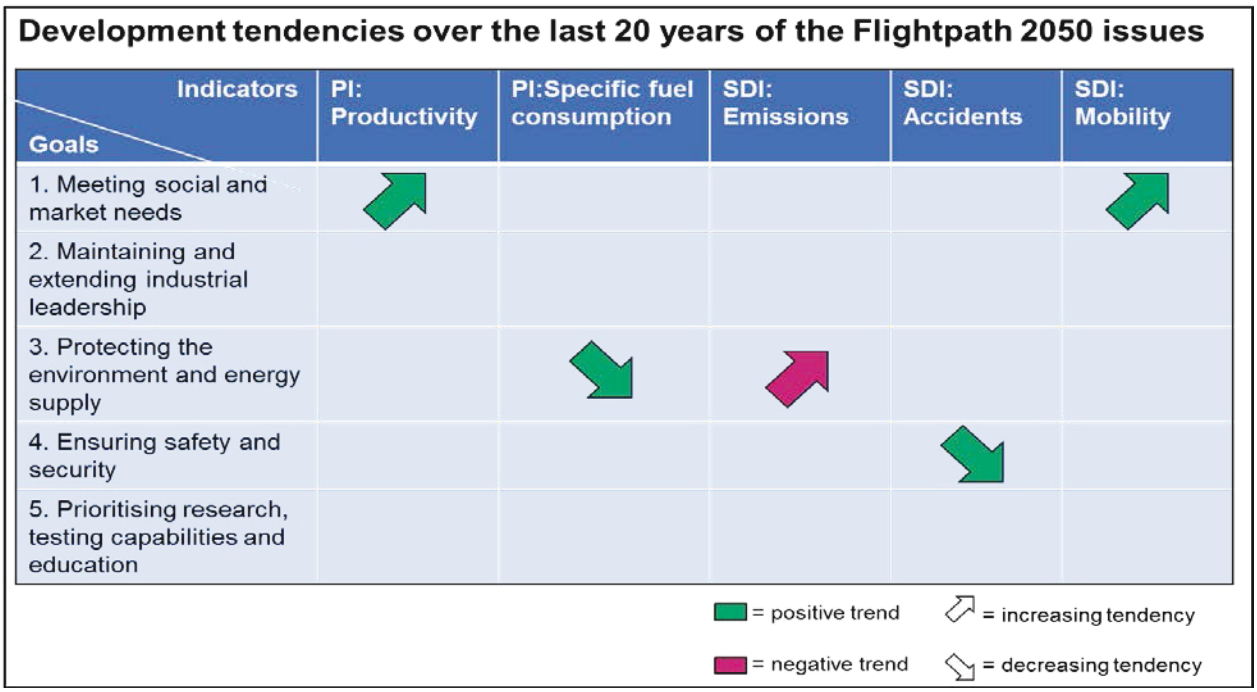

Figure 6: Development tendencies of the air transport system with regard to the Flightpath 2050 goals

The first indicator on productivity, showing the departures per IATA airline employee, outlines that in general, a higher working productivity in the air transport sector directly affects the cost-efficiency of the airlines and can be overwhelmed to the passengers what makes the whole transport system more efficient and affordable. This fits largely to the goal “Meeting social and maket needs” claiming affordable access and mobility choices for European citizens. This indicators furthermore may give hints on the achievement of the goal “Maintaining and extending industrial leadership” postulating a strongly competetive aviation industry that delivers best services by concurrently offering streamlined processes (although the ACARE goals merely deal with manufacturing and engeneering). The given trend can therefore on principle be seen as positive.

To meet the goals of “Protecting the environment and energy supply” the indicator of the specific fuel consumption has been chosen. Separately seen it shows the PKM specific fuel consumption that show the technological development which in the next step is a hint for the achievement of environmental goals. Especially when set into correlation with the indicator of CO_2 emissions it can be mentioned that the MONITOR indicator fits largely to the Flightpath 2050 goals. Nevertheless it has to be mentioned here that the specific fuel consumption shows a positive trend by reduced specific fuel consumption whereas the development of the total CO2 emissions from aviation follow a negative trend. This is a result of the growing air transport traffic and the still ongoing linkage between traffic and its negative impacts and the environment. For the future, special emphasis should therefore be put on this area of conflict.

The MONITOR indicator on fatal accidents per departure is representing the sustainable development indicators and can be set into correlation with the Flightpath 2050 goal of

"Ensuring safety and security". The development has to be regarded positive as there are less fatal accidents over as the last years whereas traffic volume has risen considerably over the same time. If the trends is ongoing that way, one can be confident to reach the ambitious goals in 2050, claiming a reduction of the number of accidents of 80% compared to 2000. Further fields of activity of MONITOR from this ACARE goal might in future be the area of security which could not be taken into accoount up to now due to data availability.

The fifth and last indicator of the chosen set is another SDI dealing with mobility, represented by the number of passengers per 1,000 inhabitants. Corresponding to the ACARE goal of "Meeting social and market needs" a positive tendency of this indicator can be drawn as an increasing number of global passengers in relation to the world population reflects an increase in the number of persons with access to an effective and affordable transport system. The conclusion has to be partly constrained as it can not be investigated on this basis if the share of passengers is spread over all regions in the same manner and it has to be considered that the specific air transport supply can differ between regions. For this reason a more differentiated spatial analysis is needed to answer questions refering to social justice. Nevertheless a positive development tendency can be stated, even more, if it is possible to include in future further MONITOR indicators in this sector.

5. Conclusion

The intention of this paper was to give an overview of different kind of assessment schemes for the long-term air transport development in regard to given strategic targets. For this purpose, the different approaches of Performance Indicators and Sustainable Development Indicators were introduced. In a second step a review of existing goals from the field of industry and politics was conducted. In this context the Flightpath 2050 goals were discussed in detail. The air transport development of the last 20 years could be analysed with help of the MONITOR indicators. The seen development tendencies of these indicators were compared with given aim directions of the Flightpath goals. This approach showed that in general the air transport development of the past 20 years is in line with Flightpath goals. The only exception remains in the field of the overall CO2 emissions development resulting from growing air transport activities. This and the further findings allowed suggesting priorities and improvements with regard to the current air transport development path but also with regard to the existing goal frameworks. It is planned to improve the set of MONITOR indicators in regard to other important aspects like noise, local air quality and the improvement of spatial accessibility by air transport.

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