Study on the Balanced Approach to Noise Management and its Influence on the Economic Impact of Air Transportation

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Content

Executive summary

Aircraft noise with its resulting environmental and social effects has become one of the main environmental issues that airports have to cope with these days. Due to the constant growing perspectives for air transport development and the rising opposition against airport expansion from the side of the public, this challenge has to be accepted by all stakeholders in order to develop effective solutions.

In order to address this issue and to propose a systematic, flexible and globally applicable solution for this challenge the ICAO Contracting States published a harmonised approach, usable on an airport-by-airport basis in 2001. This Balanced Approach consists of four pillars: (1) reduction of noise at source, (2) land-use planning and management, (3) noise abatement operational procedures and (4) operating restrictions. The main objective is that noise problems can be addressed in an environmentally and economically responsible manner within the system, guaranteeing that a clear framework secures competition and offers planning security for the established airline networks. In order to strengthen this intention it was also decided that, although all pillars of the Balanced Approach should be regarded equally, operating restrictions should only be the last resort.

This decision was based on considerations that positive impacts in form of the reduction of the noise burden can most probably be achieved at lower cost with a stronger focus on a preventive land-use-planning and the integration of noise abatement operational procedures. Meanwhile, operating restrictions limit the already low capacity of the current air transport system artificially and create economic disadvantages for aircraft operators as well as for the relevant airports and the region. This holds especially for the limitation of night flights as this part of the day is especially for cargo and express operators – besides other airline business models, – a necessary precondition to run their business according demand for next-day delivery. This is mainly due to the fact that various industries and employment rely directly or indirectly on these night activities and operating restrictions at an airport can therefore easily mean a clear reduction of the economic impact, which would not be absolutely necessary, if other measures of the Balanced Approach would be considered in first instance.

Taken all these essential aspects into account, this study provides a detailed overview on the Balanced Approach, its advantages and its limitations. In this context it is shown how and why the Balanced Approach was developed with special regard to its objectives and the current state of its implementation in Europe and the US. Furthermore, studies of the economic impact of the air transport system in general and of the business segment of cargo and express operators were analysed in form of case studies against this background in order to find out how the application and respectively the non-application of the Balanced Approach effects these activities. The result was that the understanding and the application of the Balanced Approach still differs significantly, not only from country to country but from airport to airport. These shortcomings should be improved in order to come to a more consistent and harmonised system that guarantees all involved stakeholders the needed planning security. This study should therefore be understood as a contribution to stimulate further discussions on possible improvements.

1 Scope of document

Aircraft noise and its adverse environmental effects is one of the major environmental issues that airports are facing nowadays. Noise annoyance caused by a constant growing air transport system arouses public concerns and community opposition in the vicinity of noise-affected airports. The number of people exposed to aircraft noise has increased considerably in the last half of the 20th century. Due to the introduction of quieter aircraft and the global phase out of Chapter 2 aircraft until 2002 as agreed upon in the 28th Assembly of ICAO (International Civil Aviation Organization) noise levels have been decreased on most airports worldwide. However, despite the technological progress, noise exposure shows a positive trend in the future due to growing air traffic. Furthermore, public concerns and the sensitivity of individual persons regarding aircraft noise have increased over time.

Against this background, noise mitigation measures have already been introduced in the past primarily in form of operating restrictions at individual airports (see Figure 1) to counteract this development. Despite, aircraft noise annoyance can be a major limiting factor for the expansion of existing and the construction of new airport infrastructure. Furthermore, operating restrictions at airports, such as night time curfews, limit the existing capacity of the aviation system and, hence, cause a disturbance in the traffic flow. Nevertheless, unrestricted access of existing capacity as well as airport expansions are indispensable in consideration of meeting market demand.

In particular, the express cargo industry remains a growing sector even in spite of occasional economic downturns. The business model of cargo carriers and particularly integrators depends on a flexible transport system and a complex network in order to guarantee on-time express services. Within this context especially night time handling of cargo is a vital element within the transport chain for the realisation of next-day delivery services highly requested by the economy. Beyond, the ban of night flights has also a negative impact on charter services and intercontinental flights. Nevertheless, night time operations are particularly controversial due to the effects of aircraft noise with regard to sleep disturbance of people living in the vicinity of an airport concerned. Therefore, the controversy between economic interests and constantly increasing opposition of people affected has become a perpetual challenge for airports concerned. This reveals the need to address this issue in an adequate manner.

The proliferation of uncoordinated noise mitigation programmes at airports worldwide provokes the risk of disturbing the aviation system. Furthermore, airports suffer under limited opportunities to expand the infrastructure according to the need due to growing air transport demand. On the other hand, aircraft operators face a high economic burden due to the arbitrariness of the implementation of noise mitigation programmes at airports throughout the world.

ICAO and its Contracting States dedicated themselves to elaborate a consistent and coordinated way to face this issue in an environmentally responsive and in the most cost-effective manner. As a result, ICAO published the concept of the “Balanced Approach” in the 33rd Assembly in 2001.[1] In form of guidance material, ICAO offers a global framework for a harmonised and standardised plan to address aircraft noise reduction at noise-sensitive airports.

The ICAO guidance material does not have the character of a binding law, though, it is a proposal for the implementation of an adequate process to evaluate suitable measures and the Contracting States were urged to adopt the Balanced Approach into their national

[1] ICAO (2001): Resolution A33-7.

aviation policy. Also the European Union applies the Balanced Approach in its Directive 2002/30/EC.

Within this framework, an essential element for the selection of adequate noise mitigation measures is the assessment of the noise problem at a specific airport by defining the objectives pursued and using measurable criteria to evaluate potential measures. The cost-benefit analysis (CBA) represents the core instrument for a transparent evaluation covering all relevant factors (environmental, social and economic issues according to the sustainability principle). Although different approaches already exist, some measures and their interdependencies are still not integrated in a sufficient way. Moreover, a common approach has not been achieved at this point.

This report is structured as follows:

- **Chapter 2** describes the genesis of the Balanced Approach and its elements in more detail.
- **Chapter 3** concentrates on the adoption of the Balanced Approach in the European Union and its application in the Member States.
- **Chapter 4** focuses on the US application of the Balanced Approach.
- **Chapter 5** draws an interim conclusion.
- **Chapter 6** provides a summary of selected recent economic impact studies.
- **Chapter 7** provides an interim conclusion on the economic impact studies.
- **Chapter 8** gives a review of the complete analysis.

2 ICAO's Balanced Approach

2.1 The way which led to the ICAO Resolution A33-7

Aircraft noise and its adverse effects on people and the environment became more and more important during the last decades. Noise problems are increasing because air traffic is growing and the sensitivity against noise becomes stronger. This affects a growing number of airports in various regions of the world. Thus, noise is a significant and increasing challenge for airports. Increased public awareness of people affected in areas adjacent to airports has aroused community opposition to aircraft noise leading to opposition towards any kind of airport decisions relative to capacities. Consequently, the noise issue at airports concerned climbed the political agenda. In order to address the concerns of the people affected by aircraft noise, local, national and regional noise restrictions escalated worldwide. In absence of a coordinated global framework, airports and airport authorities imposed own individual measures, including operating restrictions limiting airport capacity and the free flow of air traffic.

This development resulted, on the one hand, in airport and airspace capacity insufficiencies and hindered the ability of airports to meet the growing travel and cargo demand. Aircraft operating restrictions like noise abatement flight procedures, night curfews or noise quotas have been implemented on a local level, conflicting with airport capacity and the optimal utilisation of the existing airport infrastructure.[2] On the other hand, the industry (airlines) claimed significant economic burden on aircraft operators "[…] if forced to tailor operations to a variety of diverse operating restrictions."[3]

In order to develop a common international framework, ICAO established a **global phase-out of Chapter 2 aircraft**[4] in the extraordinary session of the 28th Assembly, in 1990. The aim of the resolution was to create a **worldwide policy** which coordinates the process of Chapter 2 phase-out in order to reduce aircraft noise at source. By reducing the effects of noise on the nearby noise-sensitive communities of airports without constraining capacity and by minimising the impact on affected aircraft operators, ICAO addressed several stakeholders (communities, airports, air navigation service providers, aircraft operators, and manufacturers) with this approach. Effective after 1st April 1995, all Chapter 2 aircraft had to be withdrawn from service by 31st March 2002.

In the following years, the discussion of a potential phase-out of Chapter 3 aircraft resumed, accompanied by the introduction of a new Chapter 4 noise certification standard. A comprehensive review of this matter was conducted by ICAO CAEP (ICAO's Committee on Aviation Environmental Protection) in 2001. As a result, CAEP concluded that the new noise certification standard would not be sufficient to solve noise problems on a global scale. Furthermore, other instruments (e.g. land-use planning and management, operational measures) would be more environmentally beneficial and more effective than the simple ban of Chapter 3 aircraft.

As shown in Figure 1, a variety of noise mitigation measures was already implemented at airports worldwide before the Resolution A33-7 in 2001. The **uncoordinated approach of individual airports** led to cumulative disputes between the different stakeholders and

[2] cf. AACC (1990).

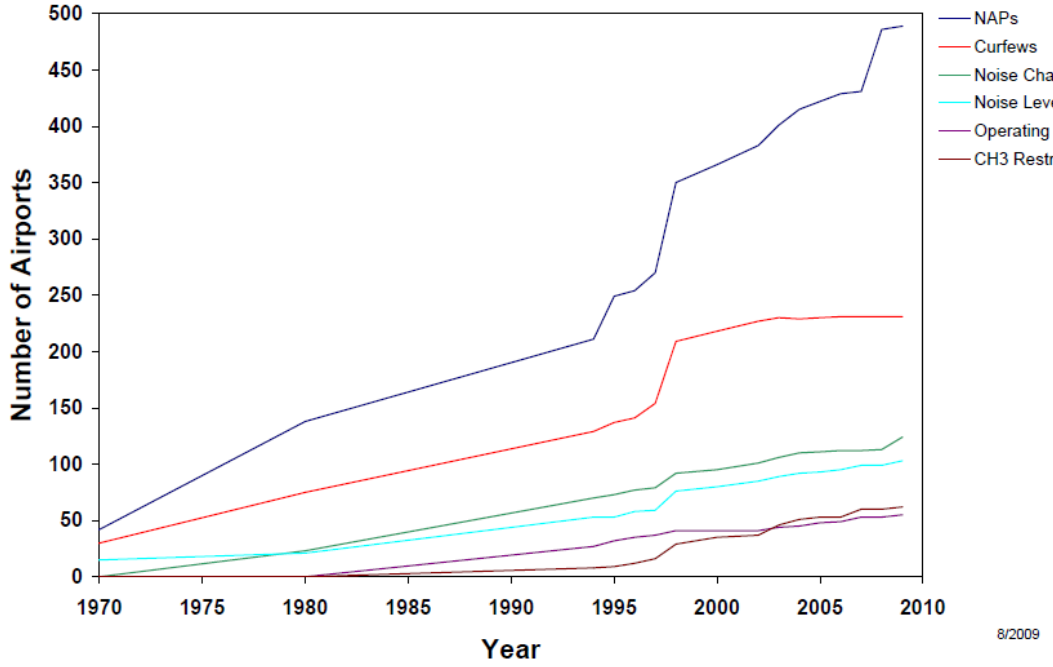
[3] IATA (1990), p.1.

[4] Aircraft which meet the ICAO certification standards specified in Volume I, Chapter 2 of Annex 16 of the Convention on International Civil Aviation.

nations. In particular, curfews are the main measure in order to reduce aircraft noise followed by noise charges and noise level limits. Chapter 3 and hush kit[5] restrictions implemented by several airports, particularly in Europe, caused high opposition. The US, for instance, were very concerned about this trend since a high rate of aircraft in operation was equipped with hush kits.

Figure 1: Growth in airport noise restrictions

Source: Boeing (2010a)



Consequently, the necessity of a more common framework on a global level gained more and more weight. The proliferation of different noise standards led to in a variety of national laws and regulations which turned out to be barriers for airport capacity expansion and economic growth. Therefore, ICAO intended to find an agreement on an international solution for local noise problems.

2.2 ICAO Resolution A33-7 of 2001

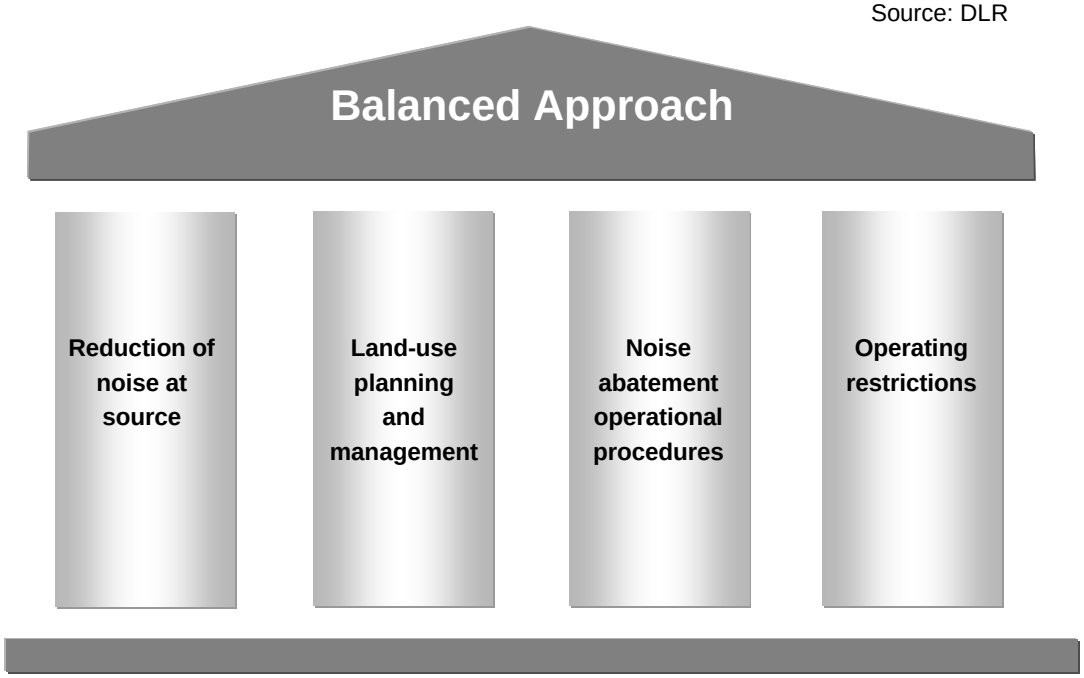
Induced by the constant discussion within ICAO and its Contracting States about the mitigation of the negative effects of aircraft noise on the communities in the vicinity of airports and its adverse environmental effects, ICAO incorporated **new policies and guidance material** to create an integrated approach. The aim was to address the noise problem in an environmentally responsive and in the most cost-effective manner. Furthermore, it should promote **consistency, harmonisation and transparency** in international civil aviation. Consequently, in the 33rd Assembly in 2001 ICAO adopted the concept of a "Balanced Approach" to noise management[6] which is based on the **four principal elements** as shown in Figure 2.

[5] Aircraft of type Chapter 2 which were subsequently equipped with mufflers (so called "hush kits") to correspond with the criteria of Chapter 3 aircraft.

[6] cf. ICAO (2001a). In the context of the 35th Assembly the latest version of the resolution (A35-5) was published in 2004: ICAO (2004a).

Figure 2: The four pillars of the ICAO Balanced Approach

Source: DLR



Since there are significant regional differences the Balanced Approach was formulated to be applied on an **airport-by-airport basis** to ensure the flexibility needed in order to be able to adjust and apply it according to specific circumstances. Within the ICAO approach **all principal elements should be considered equally**. However, **operating restrictions** should only be implemented **as a last resort** and, if implemented, an appropriate phase-in time should be granted so that aircraft operators can adjust their business plans according to the new circumstances. The four elements do not represent a fixed catalogue of potential measures, but rather four main pillars which can be extended by various measures.[7] In order to select the optimal measures for the particular airport and to ensure transparency, a comprehensive noise assessment and evaluation process should be performed consisting of the following steps:[8]

(1) assessment of the current and future noise impact at the airport concerned, compared to the noise objective to be achieved;

(2) evaluation of the likely costs and benefits of the various measures available;

(3) selection of measures with the goal to achieve maximum environmental benefits most cost-effectively;

(4) provision for dissemination of the evaluation results;

(5) provision for consultation with stakeholders at different stages from assessment to implementation;

(6) provision for dispute resolution.

The Contracting States supported the idea of a balanced approach and committed themselves to adopt it on national level. The Balanced Approach has been amended

[7] Examples of such measures are listed in the following chapter. Cf. chapters 4 to 7 of the ICAO (2004b), p. 4-1 – 7-3.
[8] cf. ICAO (2004b), p. 2-1.

continuously in the following ICAO Assemblies. For instance, public involvement was incorporated into the assessment and evaluation process to underline the vital importance of the participation of the people affected in this process.[9]

2.3 Overview of noise management instruments according to the Balanced Approach

The four pillars of the ICAO Balanced Approach to noise management incorporate several measures that can be used to mitigate the noise level at airports. In order to get an overview of the available measures, this chapter will briefly introduce the different elements of the four principal categories.[10]

The **reduction of noise at source**[11] has proven to be one of the most effective means to limit aircraft noise. Instruments in this category are typically the result of extensive research and development in the fields of aircraft and engine design, and thus are not initiated by or within the control of individual airports. Instead, they are induced by the adoption and implementation of noise certification standards in Annex 16, Volume I, to the Chicago Convention. Measures involve the introduction of newer, quieter aircraft types, as well as the reduction of acoustic output of existing aircraft types by modification. A further example of measures in this group includes the adoption of an additional Chapter 4 certification standard.

Land-use planning and management[12] measures aim at achieving compatibility of the land use with the airport activities. In order to reduce the number of people affected by aircraft noise, airports have the choice among several options which can be further grouped into:

(1) planning instruments,
(2) mitigation instruments and
(3) financial instruments.

Category (1) involves **comprehensive planning** to ensure future development in order to be compatible with the community goals by taking into account the current development. In addition, the introduction of noise zoning around airports should enable the responsible legal body to define areas where land use is subject to certain restrictions.[13] Further measures in this category are subdivision regulations, transfer of development rights and easement acquisition. Category (2) contains **building codes, noise insulation and reallocation measures** of buildings in the land surrounding an airport. Following the ICAO differentiation, category (3) includes **capital improvements planning and economic incentives** to encourage compatible land use in the noise-impacted areas. Furthermore, **noise-related airport charges** may be introduced for covering the expenses of alleviation or prevention of noise impacts in the affected vicinity of the airport.[14] Beyond this, noise charge levied on top of the landing fee depending on the aircraft's noise level may be an incentive for aircraft operators. Thus, by lowering noise emissions airlines can reduce their operating costs.[15]

[9] cf. ICAO (2007), p. 17-1.

[10] This overview is based on ICAO (2004b).

[11] cf. Ibid., p. 4-1et seq.

[12] cf. Ibid, p. 5-1 et seqq.

[13] Exemplary the German Act for Protection against Aircraft Noise (Gesetz zum Schutz gegen Fluglärm) regulates the establishment of noise protection areas in the surroundings of airfields as well as certain restrictions and measures to be taken. For further details see BMU (2007).

[14] cf. ICAO (2004b), p. 5-3 et seqq.

[15] cf. CE Delft (2005).

This, in turn, encourages them to adjust their fleet by investing in newer aircraft of lower noise level.[16]

Land-use planning and management means, particularly those of the categories (1) and (2), are appropriate during the design stage of new airports, since a proper planning process can mitigate ex ante the negative impact of aircraft noise on surrounding communities. Also existing airports can achieve positive impacts by applying land-use measures such as funding of soundproofing and constructions of noise barriers and, in the long-term, the acquisition of property. Exemplary for the latter, the international airport Dusseldorf, together with the state of North Rhine Westphalia and the city of Dusseldorf grant an option on acquisition of property in areas of high noise exposure (>75dB(A)). Thus, house owners can inform the airport if they are interested to sell their property. The airport purchases the houses under the condition that the property is uninhabited. The primary goal of this strategy is to reduce the number of affected people within these areas and, consequently, encourage the development of compatible land-use in defined noise-affected areas. Overall, land-use planning and management measures can significant reduce the adverse effects of aircraft noise in the vicinity of airports and should be taken into account by airports and authorities in order to minimise the number of noise affected people.

Noise abatement operational procedures[17] reduce aircraft noise by changing the way how an aircraft approaches to or departs from a particular airport. There are several operational measures which can significantly reduce the aircraft noise exposure: Noise preferential runways and routes encourage the use of a particular runway or route in order to concentrate flights over the least noise-sensitive areas, or at least to evenly distribute the noise disturbance among the surrounding areas. Furthermore, the use of low noise flight procedures for the take-off and landing such as the continuous descent approach (CDA) and reversed thrust can achieve lower noise levels at comparatively low cost. The appropriateness of any of these measures is subject to the physical lay-out of the individual airport and its surroundings. In all cases, though, the procedure must give priority to safety considerations. Furthermore, several operating procedures constrain aircraft ground operations. Limiting engine-run up and using the aircraft's auxiliary power unit in noise-sensitive areas or during a certain period of time, further reduces the level of noise exposure to the surrounding community can be further reduced.

Operating restrictions[18] refer to noise-related bans or limitations in the operations of all or certain aircraft types at a particular airport. In order to limit the impact of aircraft noise especially during the most sensitive time periods, they are often of a temporary nature. Operating restrictions can be classified into global, aircraft-specific, partial and progressive restrictions. Potential measures of this group are cap rules and noise quotas. Cap rules define a maximum number of operations permitted for a particular period of time, whereas noise quotas allow for a limited, cumulative level of noise that determines the actual number of aircraft movements. Beyond, night-time restrictions and curfews limit or ban aircraft movements during noise-sensitive time periods. However, while all elements should be considered equally, operating restrictions should be considered as a last resort.

[16] However, this point is not explicitly mentioned in the Guidance Material. Noise-related airport charges are exclusively determined as an instrument of cost recovery for certain expenses such as funding of insulation programmes.

[17] cf. ICAO (2004b), p. 6-1 et seqq.

[18] cf. ICAO (2004b), p. 7-1 et seqq.

2.4 Adoption of the Resolution by different stakeholder

Supported by the industry (aircraft operators and airports), regulators worldwide are urged to implement the Balanced Approach. In general, airlines and airports support the Balanced Approach. In the following, the different stakeholders' views are represented.

As the representative organisation of passenger and cargo airline industry, **IATA** actively participated in the development of the Balanced Approach working closely with ICAO CAEP to ensure that airline views were considered. From an aircraft operator's point of view, the Resolution encourages an international framework of noise mitigation management which helps to protect airlines against operating restrictions as a first resort. Consequently, IATA's night flight policy urges to consider alternative measures in a first step instead.[19] Thus, before the introduction of such a restriction, the concerned airport should assess all other available measures in accordance with the Balanced Approach. Furthermore, possible consequences for air transport services should be considered and the operators should be informed prior to the entry into force.

Regarding the **airfreight industry** (air cargo and express industry), the same position can be observed. However, concerns are mainly focussed on operating restrictions during the night, since night time operations are crucial to guarantee next day deliveries. **TIACA** (The International Air Cargo Association) supports the Balanced Approach since it offers, in their view, the most appropriate process for noise mitigation and ensures "that any resulting measures do not impede the competitiveness of the airfreight industry or the broader economy."[20] **EEA** (European Express Association) points out that the proper application of the Balanced Approach will lead to "a fair balance between protecting residents from noise and ensuring the well-being of the European economy."[21]

Due to this fact, it is comprehensible that **aircraft operators** favour the Balanced Approach. In particular **land-use planning** and management is emphasised by **IATA** and other stakeholders as a crucial element which should be considered in a more comprehensive manner to achieve long-term noise benefits. The argument is based on the fact that lacking an adequate land-use control benefits resulting from new noise standards may be compromised by subsequent encroachment of residential developments. [22]

Beyond, **ACI** (Airports Council International) declares its support of the Balanced Approach with all its elements.[23] **Airports** are confronted with the Community opposition of the people directly affected by aircraft noise. In order to satisfy their complaints comprehensive noise mitigation planning and management is required. Even though, the introduction of operating restrictions can provide immediate noise relief, this measure is not necessarily the most cost-effective solution to the noise problem. Therefore, it should not be considered as a first resort. The introduction of operating restrictions limits existing airport capacity causing more congestion during other times of the day as well as underutilisation of the capacity at the restricted time. Beyond this, it results in a loss of revenues for the airport. Furthermore, it can restrict competition and hinder economic development if those measures are not applied in a common manner throughout the different world regions. The Balanced Approach of ICAO can help to solve this problem if it is applied on a global level.

[19] cf. IATA (2004), p. 14.
[20] cf. TIACA (2010).
[21] EEA (2004), p. 15.
[22] cf. IATA (2004), p. 15 et seqq.
[23] cf. ACI (2009).

As a relevant stakeholder, **passengers** lack to have their own representation or interest group. Therefore, no official statement is available from their side. However, certain customer groups might favour the Balanced Approach due to their price-sensitive behaviour. In general, night flights are less expensive due to the inconvenient travel time. Thus, certain customers might prefer night flights. Transfer passengers widely accept night transfers – for instance transfer services offered by Middle-Eastern airlines. In absence of night flights in Europe, passenger choice could be extended and competition could be increasing, particularly, on intercontinental flights. A further passenger group - those arriving late in the evening at an airport with stringent night restrictions - might be interested in night operations since they have to fear that a delayed flight will be diverted to another airport, which leads to a tremendous loss of time arriving at the final destination.

Employees are also an important stakeholder and should not be neglected. Although they have lobby groups to represent their interests, no explicit statement exists concerning the Balanced Approach. However, for instance the German labour union “Vereinigung Cockpit” which represents commercial pilots and engineers argues against an absolute night flight restriction in Frankfurt Airport since this would lead to massive job cuts, particularly with regard to charter and cargo operators.[24] Furthermore, they favour a balanced solution to reduce aircraft noise.[25]

Consequently, the Balanced Approach includes vital elements to reduce noise which is in the interest at least of the industry, most probably also to the passengers. It is considered to be the best instrument to avoid the proliferation of different noise standards at airports worldwide, which impedes competition. The selection of the most appropriate mitigation measures should be based on a comprehensive and consistent evaluation in order to reduce aircraft noise in the most cost-efficient and environmentally beneficial manner. Furthermore, the harmonisation and transparency achieved by this integrated approach ensures the confidence of the industrial stakeholders.

2.5 Impact of noise mitigation instruments on airline models

Within the aviation market several airline business models can be found: full service network carriers (FSNC), low cost carriers (LCC), holiday/charter carriers, regional carriers, hybrid carriers, traditional freight carriers, and integrators.[26] Since business models vary amongst others in their strategy, fleet mix (e.g. aircraft type, importance of time windows) and airports served (e.g. hub, secondary airports), the impact of different noise mitigation measures on a specific airline model can be different.

In the following, the four principal elements of the Balanced Approach as described above are briefly examined in consideration of their potential impact on the different airline business models with a special focus on integrators.

The first pillar, **reduction of noise at source**, as described above is technology-driven and subject to ICAO certification. Noise reduction is achieved by adoption and implementation of noise certification standards as defined in the Annex 16.[27] Currently, Chapter 4 aircraft are state-of-the-art while Chapter 2 aircraft have already been banned from international airports

[24] cf. Vereinigung Cockpit (2002).

[25] cf. Vereinigung Cockpit (2010).

[26] The categorisation follows the differentiation based on the DLR definition. For a comprehensive overview of different airline business models see DLR (2008).

[27] Certification standards are contained in Annex 16 - Environmental Protection, Volume I – Aircraft Noise to the Convention on International Civil Aviation. Practical guidance on the implementation of Annex 16 is contained in the Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft (Doc 9501).

as decided in the 28th Assembly in 1990.[28] Banning a specific aircraft type induces high investments for aircraft operators since new aircraft technology and the modernisation of their fleet are necessary.

Besides differences that can be observed on a regional level, some airlines are more affected than others depending on the average age of the respective fleet. Thus, airlines which operate older aircraft are more affected since more investments are necessary. In order to guarantee that the economic burden does not cause any discrimination among the airline industry, ICAO already considers a phase-in of the rule over a pre-defined period of time[29] and more flexible rules for developing countries' airlines. Furthermore, the Chapter 2 aircraft phase-out considers the lifecycle of an aircraft (25 years) and contains a special settlement for aircraft which have not yet reached their complete lifecycles.[30] These compromises support the acceptance on the airline-side.

The second pillar of the Balanced Approach, **land-use planning and management**, deals on the one side with the planning and managing of the land in the vicinity of airports which is airport's concern and does not directly influence the airlines and cannot be influenced by them. A potential instrument within this category, however, which affects airlines operating at a specific airport, is the application of noise-related airport charges. Noise charges are levied, for instance, per take-off based on the aircraft's noise level (e.g. FRA, BRU, CDG), per departing passenger (e.g. VIE) and per landing. In consideration of noise charges which are based on the aircraft's noise level, those airline models operating aircraft types with a higher noise level have to pay a higher charge than others, thus, raising the operational costs of the affected airline. Therefore, this economic instrument might stimulate aircraft operators to reduce their operating costs by exchanging the aircraft type used for a quieter type. Nevertheless, all airline models can be affected by noise charges as there are different charging systems. In general, those airlines which operate newer aircraft benefit from such a system which operates newer aircraft.

Noise abatement operational procedures, the third pillar of the Balanced Approach, could have an effect on the aircraft fleet operating at an airport. Any of these measures might limit the access of an aircraft to an airport if it does not comply with the specific performance characteristics. An overall effect can not be defined since it depends on the concerned airport, which procedure is to be applied and what kind of fleet mix is serving it. Therefore, any airline business model might be affected. Since CDA needs more capacity according to ATC information they are more applied at night time, where capacity limits are less severe. Consequently, those business models which are more dependent on night flights are more affected by this possibility to reduce noise. The dependency of the different business models on night flights will be described next.

In general, noise mitigation measures in form of **operating restrictions** influence the airlines by limiting or reducing aircraft access to airports. Focusing on the fourth element of the Balanced Approach, it is comprehensible that a non-restrictive 24 hours operation license of an airport might be a more or less important criterion for several airline business models. In particular, restrictions during the night time have a negative impact on airlines.[31]

[28] cf. ICAO (1990).

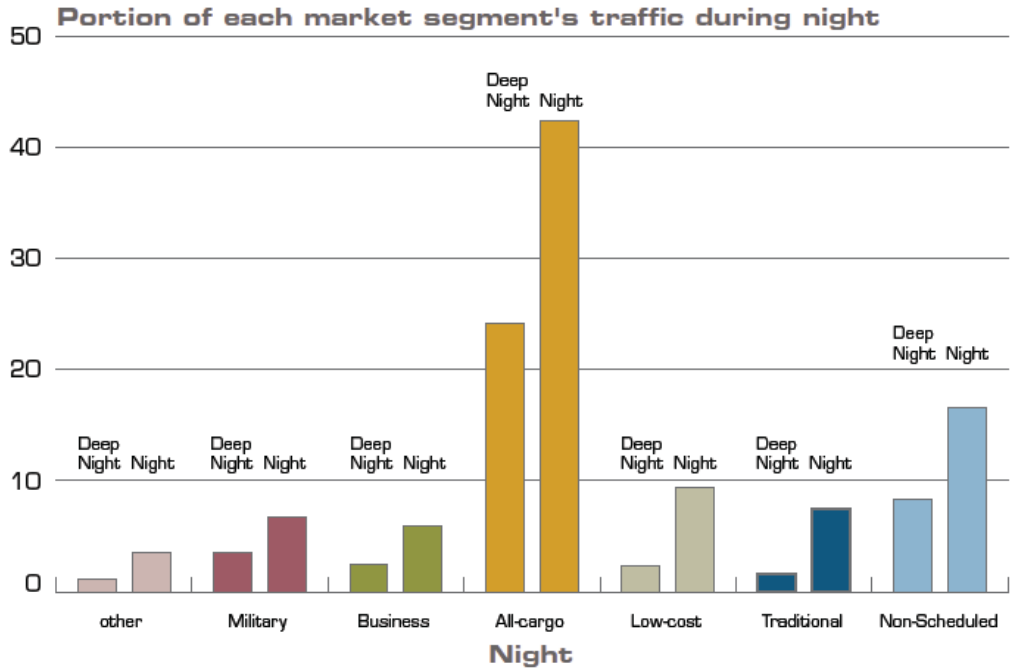
[29] In case of Chapter 2 phase-out the timeline was set starting from 1995 until the total ban in 2002 (7 years).

[30] See chapter 2.1 for further details on the Chapter 2 aircraft phase-out.

[31] A comprehensive analysis on the impact of night flight restrictions differentiated by airline business models can be found in the MPD study published by the EC in 2005. Cf. EC (2005), p. 14 et seqq.

Figure 3: Traffic during night by market segment[32]

Source: EUROCONTROL (2009): Trends in Air Traffic, Vol. 5, Fig. 16, p. 30.



The figure above shows that scheduled services ("Traditional") and LCCs account for a lower share of aircraft movements during the night while non-scheduled services (charter operations) show a higher share. Therefore, the latter airline business might be more affected by night time operating restrictions. In general, most scheduled operators prefer the day due to the passenger's preferences. However, the development in the last years shows that FSNCs and LCCs extended their operations within the marginal hours around the night due to capacity constraints during the day and cost pressure. [33] Thus, they might be able to operate a further turn around of the aircraft per day. **FSNCs** operate a hub-and-spoke model and offer a global network connecting different regions and continents with each other.[34] Such hub-and-spoke-airlines concentrate on connecting feeder flights with intercontinental flights. In particular, with regard to intercontinental flights night time operations can be essential. However, due to the preferences of the passengers departures and arrivals are usually not scheduled at night. A prerequisite of this business model is sufficient airport capacity especially early in the morning and late at night. These morning and evening peaks are due to the need of connecting long-distance flights with short-haul feeder flights. A scheduled long-distance flight in the early morning is associated with the prior arrival of feeder flights[35] and vice versa for the evening to ensure a maximisation of load factor. As the maximization of connections and the minimization of connecting time between the flight segments, airlines operating on an intercontinental level have to cope with different time zones. Therefore, the implementation of a partial or full night curfew can have a considerable negative economic effect on the airline concerned.

[32] Deep night refers to the period from 00:00-4:59 while night includes the timeframe from 23:00-23:59 and 05:00-06:59. Cf. EUROCONTROL (2009), p. 16.

[33] cf. EUROCONTROL (2009), p. 30.

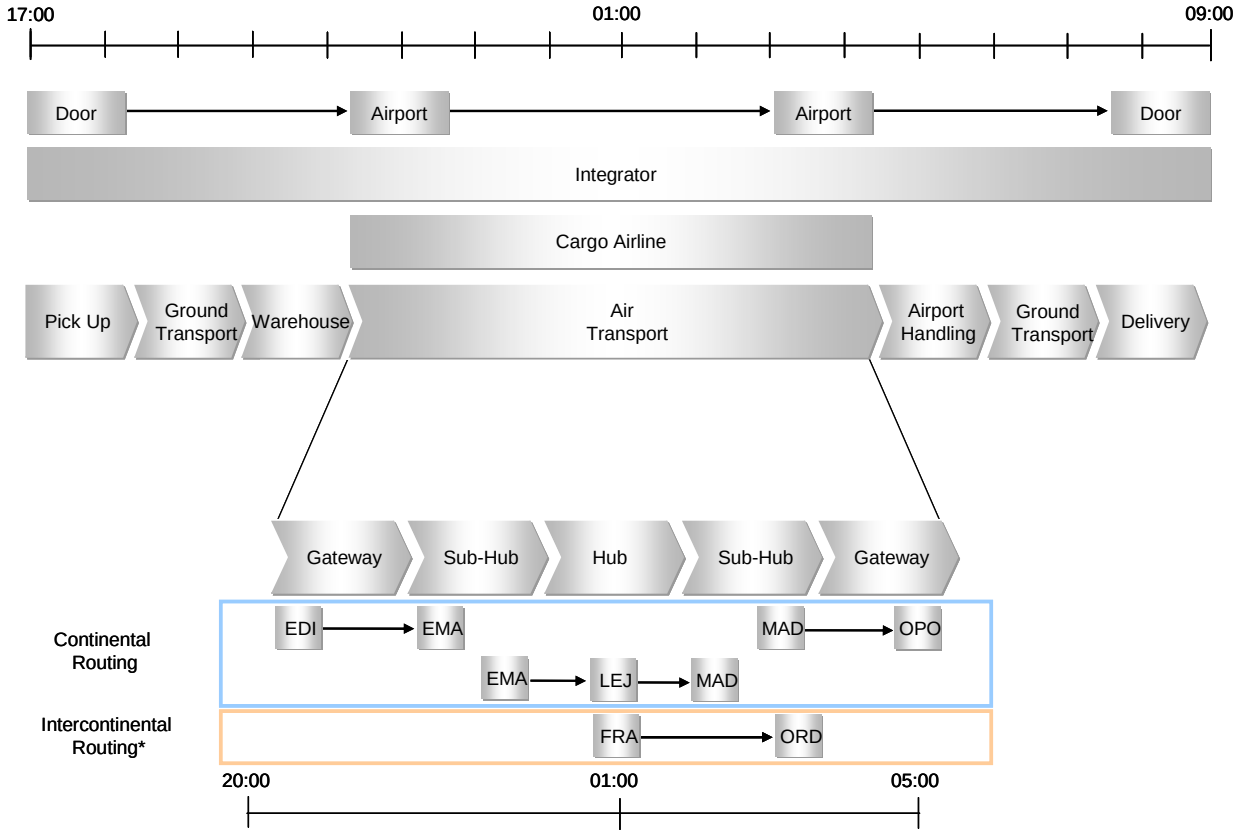
[34] For further details see DLR (2008), p. 5 – 7.

[35] Feeder flights are operated by the FSNC and/or by associated regional carriers.

As shown in the figure above, **all-cargo flights**[36] account for the highest share of aircraft movements during the night (24% in the deep night and 42% during the night). Night operations are essential for all-cargo flights[37] (see also chapter 6.3) due to their business model. Therefore, this segment is most affected by the introduction of night time restrictions. Particularly integrators operate a hub-and-spoke network during the night connecting each world region. Their **business model is based on overnight hubbing**.[38] The figure below illustrates the importance of night flights for the air cargo and in particular the integrator industry.

Figure 4: Transport chain of cargo airline and integrator

Source: DLR



The figure reveals that night flight options represent an essential prerequisite for cargo airlines and integrators, in order to guarantee the time-definite availability of a shipment at its destination. Whereas cargo airlines rely on night flights to offer point-to-point connections from one airport to another, integrators request night-time aircraft movements to operate their complex hub-and-spoke networks. This network design allows them to exploit operational synergies such as higher load factors, which, in turn, reduce the number of aircraft movements during night times. However, the integrated transport chain does not only

[36] Cargo flights in this data have been identified by classifying each flight based on the following rules: all-cargo operator, an aircraft type which is always all-cargo, an aircraft type which for particular operators is a cargo type, call sign which particular operators assign to their cargo flights. These rules do not cover belly-hold cargo. A major proportion of general freight, global and European mail air cargo is transported in the bellies of passenger aircraft on scheduled services. However, high value express freight is usually not carried in belly-holds. Therefore, this data should include a large proportion of this type of freight. cf. EUROCONTROL (2009), p. 18 et seq.

[37] cf. EUROCONTROL (2009), p. 30, 56.

[38] cf. DLR (2008), p. 13.

streamline operational processes; it also provides time-critical and time-definite product features with regard to the pick-up or delivery time of a shipment at customer site. The sophisticated business model of integrators, which also includes the ground transportation of shipments, enables them to offer special product options such as a pick up time after 5 p.m. or very early availability of the shipment at destination. The flexibility of these product options for the customers allows integrators to meet their customers' needs for high speed and highly reliable door-to-door transportation services and thus gives them a competitive edge over other players in the express cargo industry.

As shown, a flexible and unrestrictive operating basis is crucial to ensure worldwide deliveries in a short time frame and within the established logistic network. Therefore, the implementation of arbitrary operation restrictions at airports served (especially at hub airports) can lead to high economic losses for the integrator. This is mainly the case when investments at an airport have already been taken and later operating restrictions create sunk costs. A prominent example is DHL and the relocation of its European hub from Brussels to Leipzig/Halle Leipzig in 2008. The decision resulted from the lack of planning security since a stable long-term framework, which facilitates to realise investments with a focus up to 40 years was not foreseeable at Brussels airport (see chapter 6.5 for more details).

3 Noise management at European airports

3.1 Introduction

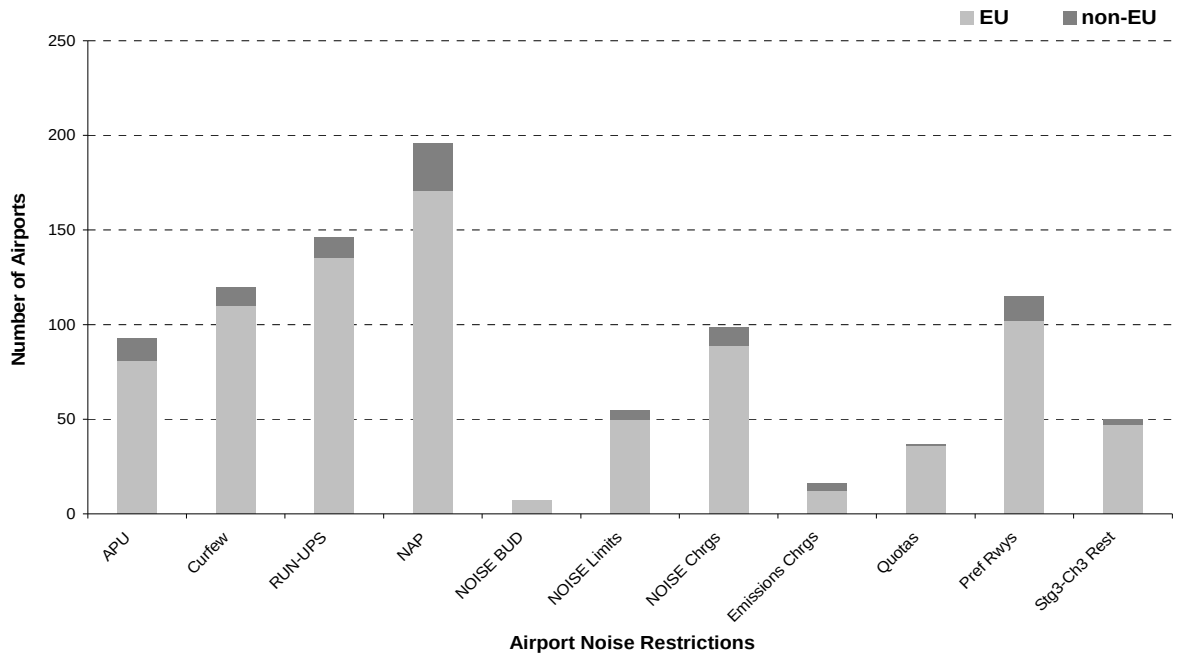
In Europe, airports have already implemented several noise mitigation measures according to existing national legislation and complementary Union legislation.

Concerning **noise reduction at the source**, these measures are limited to new technology developments and the adoption of stricter noise certification standards on an international level. Taking into account environmental factors, technical feasibility and economic consequences, Directive 2006/93/EC[39] regulates the operation of chapter-3-certificated civil subsonic jet aeroplanes. Furthermore, it has to be mentioned that issues of **land-use planning and management** fall into the exclusive legal competence of the respective Member States. Therefore, no harmonised approach can be found on European level. In contrast, several **noise abatement operational procedures** are in force ranging from preferential runway use and restrictions on maintenance engine run-up to specific flight routes. In different Member States the authorities have established **operating restrictions** to solve noise problems of the airport.

Figure 5 gives an overview of the current noise mitigation measures applied at European airports. The figure is based on the data collected by Boeing.

Figure 5: Overview of current European* airport noise restrictions[40]

Source: DLR based on Boeing (2010b)



* EU and Non-EU-airports

[39] cf. EC (2006a).

[40] For a definition of the specific measures listed in this figure see Annex, Table 1.

The Boeing database "Airports with Noise Restrictions"[41] is publicly available and includes 632 airports worldwide. The information and the data on this website are provided directly by the airports themselves. Focussing on Europe, 230 European airports are listed in the Boeing database of which 204 airports are located in the EU. The figure includes all 230 European airports differentiated according to their location (EU or non-EU). As shown in the figure, the measures primarily applied at European airports are noise abatement procedures (NAP) followed by operating restrictions. Regarding the latter the following restrictions have been introduced at EU airports: 110 curfews[42], 50 noise limits, 47 Chapter 3 restrictions, 36 noise quotas and 7 noise budgets. However, this overview does not give any information if these measures were implemented under the Directive or not.

Although direct examples of the application of the Balanced Approach can not be provided, ICAO CAEP published a working paper in 2006 which gives examples for best practices of how the different elements of the Balanced Approach can be applied.[43] Following European airports are listed: Amsterdam Airport Schiphol (Netherlands) and London Airports (UK). These airports use a combination of specific measures adjusted to the special circumstances of the airport.

Within the European Union, Directive 2002/30/EC introduced the ICAO Balanced Approach. While it focuses on a harmonised introduction concerning operating restrictions as one pillar of the Balanced Approach, the following chapters will describe the development and implementation of the Directive.

3.2 Development of the Directive 2002/30/EC

After the global phase-out of Chapter 2 aircraft and the adoption of a new Chapter 4 certification standard in June 2001 no timetable was set for the phasing out of Chapter 3 aircraft neither for a further standard with higher incentives. Due to the absence of such a timetable, **pressure for alternative measures** to limit noise at airports emerged. Although noise standards applicable to individual aircraft types have been further developed, growing traffic levels affecting an increasing number of airports in the EU have demanded the application of more stringent measures to limit the impact of aircraft noise especially during the most sensitive periods (evening, night and weekend), or to limit the use of older, noisier aircraft that are only marginally compliant with Chapter 3.[44]

In order to fulfil these requirements, more and more airports have decided independently from each other to introduce **operating restrictions** instead of other available noise mitigation measures. Consequently, there have been significant inconsistencies in restrictions between countries, especially with regard to partial night time restrictions that are based on different aircraft categories in different countries[45]. This led to **significant operational consequences** and, thus, encountered resistance from aircraft operators. In their eyes, operating restrictions which are commonly based on local decisions are often arbitrary and incomprehensive affecting their freedom to operate their business.

In particular, **Regulation (EC) No. 925/1999** ("hushkit" regulation) concerning operating restrictions of so-called hush kit aircraft led to a **dispute with the US**. The recertification of Chapter 2 aircraft to be in conformity with the new Chapter 3 standard by converting turbines

[41] cf. Boeing (2010b).

[42] The definition of "curfew" includes different operating restrictions in force such as noise level limits, noise quotas, noise budget or the ban of specific operations for certain aircraft and during certain times of the day.

[43] cf. ICAO (2006).

[44] cf. EC (2008).

[45] cf. MPD (2007).

with hush kit devices was a widespread instrument particularly in the US. A ban on hush kitted aircraft would, therefore, have had a major impact on those airlines operating with converted aircraft. In November 2000, the US applied to the ICAO Council for settlement of a difference with 15 European countries stating that the "hushkit" regulation as implemented by the EC was not compatible with the Convention on International Civil Aviation and Annex 16.[46] In October 2001, the European side announced to replace the regulation by a new Directive which would be in conformity with the ICAO Resolution A33-7. In return, the US agreed to withdraw its application if all elements to the dispute were satisfied.[47]

In March 2002, the EC adopted the **Directive 2002/30/EC**[48] concerning the rules and procedures for noise-related operating restrictions at Community airports. The main objective of the Directive is to provide a **common framework for the Member States** to facilitate the introduction of operating restrictions in a consistent manner at an individual airport level.[49] The Balanced Approach as stated in the resolution of the 33rd ICAO Assembly was explicitly adopted into EU law and is defined in detail and in full consensus with the ICAO approach in Article 2(g). With Article 15 of the newly implemented Directive the European Commission **repealed** the prior **Regulation (EC) No 925/1999** concerning the controversy operating restrictions of hush kit aircraft. However, the Directive allowed Member States the ban of marginally compliant aircraft at individual airports if necessary.[50]

According to the Directive, Member States have several options to consider when tackling noise issues at the local level, depending on the circumstances at hand. They are required to "adopt a balanced approach in dealing with noise problems at airports in their territories"[51] in order to limit or reduce the number of people significantly affected by the harmful effects of noise in comparison with the 2002 situation. By incorporating ICAO's Balanced Approach to noise management, the legislation obliges Member States to consider not only operating restrictions in addressing the noise problem at airports, but also to take into account alternative ways – reduction of noise at source, land-use planning and management, and noise abatement operational procedures. Indeed, operating restrictions on aircraft should only be introduced when the other available measures do not provide any, or sufficient, capacity to limit the noise problem at airports.

Hence, in decisions of noise-related operating restrictions the authorities of the Member States are obliged to apply consistent assessment rules and procedures in accordance with the Directive. Therefore, the Resolution A33-7 and the ICAO Doc 9829 AN/451 are critical and explanatory documents for the interpretation of the Balanced Approach on the level of Community law. Both the withdrawal and the partial operating restrictions of certain types of aircraft (non chapter 4 aircraft) during specific times (such as night flight bans) must meet the requirements of the Directive.

Although Directive 2002/30/EC is legally binding for all 27 Member States, the rather dynamic nature of the legislation provides the Community with the flexibility to determine the form and methods of its implementation into national law. [52]

[46] cf. ICAO (2000).
[47] cf. ICAO (2001b).
[48] cf. EC (2002).
[49] cf. EC (2002), Art. 1(a)
[50] cf. EC (2002), Art. 6.
[51] cf. EC (2002), Art. 4(1)
[52] Besides the Directive 2002/30/EC the European Commission introduced Directive 2002/49/EC regarding the assessment and management of environmental noise which obliges all Community airports > 50,000 movements to prepare strategic noise maps and action plans for the reduction of noise issues.

3.3 Implementation of Directive 2002/30/EC into national law

According to Article 16 of Directive 2002/30/EC, all Member States were obliged to implement the elements of the Directive into national law by 28th September 2003. The EC monitors the application of Community law. Since some Member States failed to adopt the Directive into national law within the set timeframe, the EC started infringements proceedings against ten Member States (Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Austria, Portugal, Finland and Sweden).[53]

In addition, the Commission requests the Member States to comply with EU law. Therefore, an action against the Kingdom of Belgium was brought before the European Court of Justice in November 2005 by the Commission.[54] In June 2007, the Court ruled that the Kingdom of Belgium failed its obligations under Directive 2002/30/EC by adopting a measure liable seriously to compromise the result prescribed by the Directive. Belgium regulated night flights of certain types of civil subsonic jet aeroplanes by Royal Decree of 14th April 2002 during the transposition period of the Directive which entered into force on 28th March 2002.

Exemplary, Germany implemented Directive 2002/30/EC within §§48a to 48f of the Luftverkehrs-Zulassungs-Ordnung (German air traffic licensing regulation) as far as needed in the opinion of the legislature.[55] Elements not explicitly implemented in §§48a et seqq. are subject of already existing national regulations. The UK as second example incorporated the Directive into UK legislation by The Aerodromes (Noise Restrictions) (Rules and Procedures) Regulations 2003.[56]

3.4 Assessment of the implementation of the Directive

In 2007, a first **review on the application of Directive 2002/30/EC** has been carried out in order to evaluate its effectiveness with regard to the reduction of the total impact of aircraft noise within the EU.[57] The study's strategy was based on a **three-fold approach**. Firstly, it contains an extensive analysis of aircraft movements in the base year 2002 and 2006 at 70 EU airports currently or potentially soon to be covered by the Directive's traffic limit of 50,000 aircraft movements per annum. Secondly, the same airports and other stakeholders have been interviewed and were asked to provide facts and figures on operating restrictions and other measures related to noise management. Thirdly, noise contours were modelled for five case study airports to estimate the effect of banning marginally compliant aircraft.

Given the limited period of time since the Directive's entry into force, the surveyed **airports** indicated heterogeneous experiences with the legislation.[58] On the one hand, it was mentioned that the Directive had no direct influence on the noise management around their airports, since it is already foreseen by national law and thus was already implemented, or at least planned, before the Directive entered into force. Hence, the Directive contributes rather indirectly - for instance by raising awareness for the noise problem and by highlighting all potential measures available. On the other hand, airports reported the Directive to have a direct influence, as it encourages individual airport action and enables night restrictions. However, this opinion was only shared by a few airports. Several airports stated the Directive to make the process of noise management at airports - in particular, the implementation of restrictions - more difficult due to the requirements of its Annex 2. This annex requires

[53] cf. EU (2003).
[54] cf. EC (2006b).
[55] cf. Hobe / von Ruckteschell (2009), p. 1045.
[56] cf. UK (2003).
[57] cf. MPD (2007).
[58] cf. MPD (2007), chapter 5.1.4, p.33 et seqq.

airports to conduct an assessment as to costs and benefits when taking alternative noise abatement measures in the airport vicinity. From an airport operator point of view, this annex is too restrictive and impedes new noise abatement measures due to the complex assessment procedures required.

In the scope of the interview programme, **industry and other stakeholders** have been asked to express their specific point of view regarding the Directive. CEFA (Council for Environmentally Friendly Aviation) which consists of various airline operators associations[59] emphasized that although the Directive protects aircraft operators against non-arbitrary impositions of operating restrictions, the focus laid on in the Directive covers only one of the four principal elements of the Balanced Approach.[60]

The study particularly focused on the revision of the current definition of **marginally compliant aircraft**[61], the application of operating restrictions of these aircraft as defined in Article 6 of the Directive and the need for greater stringency. The results show that the total amount of marginally compliant aircraft operating at Community airports is relatively low.[62] The analysis revealed that only three airports banned so-called “minus 5” aircraft totally (e.g. CDG) and four partially, mainly at night while another ten airports consider a ban in the future. In addition, the analysis indicates a considerable drop (80%) in the operation of marginally compliant aircraft in terms of movements at Community airports. Aircraft compliant by between 5dB and 10dB decreased up to 25% while the use of Chapter 4 aircraft increased by 20%.[63] This could be due to the trend that airlines replace non compliant aircraft with Chapter 4 aircraft in order to circumvent potential restrictions.

With 18 airports not participating in the interview the response rate was 74%. However, this rate varies dependent on the type of questions raised. Therefore, the study does not provide a full assessment of all Community airports. Furthermore, the answers can differ in their interpretation by the individual airport. Thus, this study is rather an overview reflecting the acceptance of the Directive or the need for changes from a stakeholder point of view, but it is not – as intended – an overview on the application of the Balanced Approach.

The study results have been summarised in a Communication on the implementation of the current Directive on airport noise management published by the EC.[64] As pointed out by the report, the present Directive is not sufficient to reduce noise around airports, particularly with regard to a growing traffic demand. In contrast, the amount of people affected will increase in the future. Furthermore, measures of the Directive have been implemented by only a limited number of Community airports. Therefore, the EC aims at a clarification of the provision and the scope of the Directive but does not provide any particular policy options in the report. Before a formal decision on further steps is made, the Commission expressed its willingness to receive comments from the stakeholders.

59 Council for Environmentally Friendly Aviation (CEFA) included following members: Association of European Airlines (AEA), European Business Aviation Association (EBAA), European Express Association (EEA), European Regions Airline Association (ERA), International Air Carrier Association (IACA) and in addition the European Low Fare Airlines Association (ELFAA).

60 cf. MPD (2007), p. 60.

61 cf. EC (2002), Article 2(d). Marginally compliant aircraft, so-called “minus 5” aircraft, are defined as civil subsonic jet aeroplanes that exceed the Chapter 3 standards by a cumulative margin of not more than 5EPNdB (Effective Perceived Noise in decibels).

62 Only 0.4% of all movements at the 70 airports analysed are by marginally compliant aircraft while 88% meet Chapter 4 standards. MPD (2008), p. 3.

63 cf. MPD (2007), p. 3.

64 cf. EC (2008).

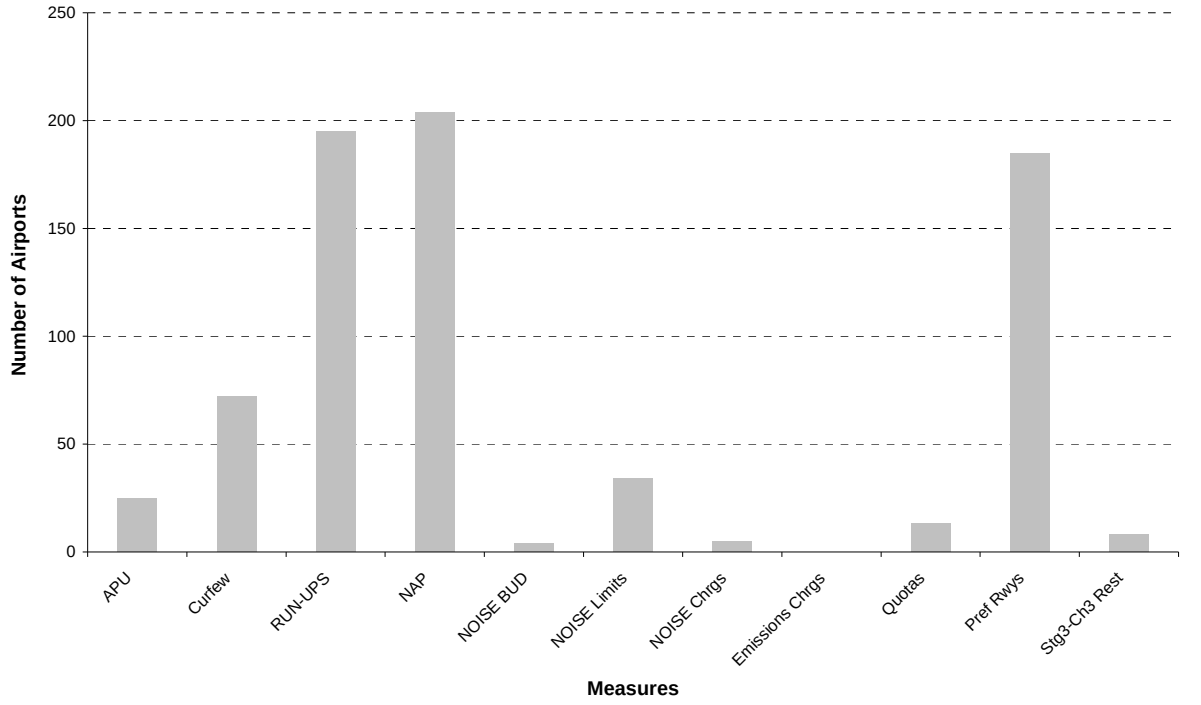
4 The US approach of noise management

The US aviation noise policy differs in its application compared with the approach applied in the EU. In the following, the US approach is described briefly as a further example of the application of the Balanced Approach.

Figure 6 gives a general overview of noise mitigation instruments applied at US airports. While curfews, noise limits and quotas are operating restrictions, noise charges represent an economic instrument which might encourage aircraft operators to operate quieter aircraft. In regard to noise charges, Figure 6 shows that only five of the 290 US airports listed in the Boeing database levy noise charges.[65] This can be explained with the fact that US airport proprietors can impose passenger facility charges[66] which can be used for capacity enhancement and noise mitigation programmes.

Figure 6: Comparison of US and European airport noise restrictions

Source: Own diagram based on Boeing (2010b)



Before the implementation of a national aviation noise policy, airports suffered from growing noise complaints after the deregulation of the US aviation market in 1978. In order to address the concerns of the people affected living in the vicinity of the concerned airports, access restrictions have been implemented in an uncoordinated and inconsistent manner at airports throughout the country. These restrictions led to a limitation of airport capacity which in turn disturbed the free flow of air transport.

[65] Only the following US airports introduced a noise surcharge: Laurence G Hanscom (BED) in Bedford, Long Beach (LGB), Palm Beach International (PBI), Sarasota-Bradenton (SRQ) and Truckee Tahoe Airport (TRK).

[66] Authorized by Airport and Airway Improvement Act, 49 U.S.C. §40117. For further details see also FAA (14 CFR Part 158 – Passenger Facility Charges (PFC's). (http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=cc95bb3ff64f211502da84d2a35799a4&rgn=div5&view=text&node=14:3.0.1.3.25&idno=14)

The proliferation of these individual operating restrictions aroused the concern about the need of a national aviation noise policy. In response, the US Congress enacted the 1990 Airport Noise and Capacity Act (ANCA) to guarantee a coordinated and consistent approach for all airports in the United States. These regulations, implemented by the FAA (Federal Aviation Administration) in 14 CFR (Code of Federal Regulations) Part 161, establish a programme for reviewing noise and access restrictions concerning Chapter 2 and Chapter 3 aircraft.[67] Hence, the competence of the airports' authority to implement operating restrictions was reduced significantly.

After the entry into force (1st October, 1990), all restrictions affecting operations of Chapter 3 aircraft have to be approved by the FAA while existing restrictions were granted as grandfather rights. Airport proprietors have to apply for the implementation of an operating restriction which will then be evaluated by the agency. An approval will only be granted if the following six statutory conditions are supported by substantial evidence[68]:

(1) restriction is reasonable, non-arbitrary, and non-discriminatory;

(2) restriction does not create an undue burden on interstate or foreign commerce;

(3) restriction is not inconsistent with maintaining the safe and efficient use of navigable airspace;

(4) restriction does not conflict with a law or regulation of the United States;

(5) adequate opportunity has been provided for public comment on the restriction;

(6) restriction does not create an undue burden on the national aviation system.

A central element of the US approach for the selection of potential capacity-related airport projects, such as noise mitigation projects, is the CBA.[69] This guidance provides a consistent approach for comparable analyses. The concerned airport has to conduct a similar analysis to prove the cost-effectiveness of the proposed measures. The systematic US approach with regard to operating restrictions considers a broader point of view on a federal level with the aim to ensure the functioning of the aviation system considering a great variety of aspects which might cause adverse effects (e.g. safety and economic issues). Thus, this approach might increase the acceptance of all stakeholder concerning decisions made by the agency.

The FAA publishes notice and approval concerning airport noise access restrictions which are subject to Part 161 on its website. Furthermore, it provides detailed information, data and statistics concerning airport noise compatibility planning activities which are regulated in Part 150. [70] On the basis of the case in the table below the US approach concerning operating restrictions can be illustrated in a clear manner.

[67] cf. FAA (2010a).
[68] cf. FAA (2010a), § 161.305 (i) – (vi).
[69] cf. FAA (1999).
[70] cf. FAA (2009a).

Table 1: Case Study

Burbank-Glendale-Pasadena Airport Authority

The application of Burbank-Glendale-Pasadena Airport Authority for the implementation of a full night time curfew affecting Chapter 3 aircraft at Bob Hope Airport (BUR) is a recent example for the practice of US regulations. In May 2009, the Authority completed its application which was then evaluated by the FAA.[71] In the evaluation report the agency concluded that the Authority failed to support four of the six statutory conditions (C1, C2, C3, and C6). Several arguments were raised by the FAA.

Regarding **condition 1** (reasonable, non-arbitrary, non-discriminating) the FAA criticised the way the projected noise was determined especially in consideration of a too optimistic forecast of operation growth. In addition, the agency emphasized that the Authority only have considered a limited number of alternatives and that the CBA was flawed. In total, the two alternative restrictions had a higher cost-benefit ratio. In sum, it showed that the full curfew was not the most cost-effective measure. Therefore, the Authority failed to support substantial evidence for condition 1.

Condition 2 (does not create an undue burden on interstate or foreign commerce) failed since the FAA analysis demonstrated that "the costs of the full curfew would exceed the benefits."[72] In particular UPS provided information on the possible impact the full curfew would have on its operations. The implementation of such a measure would imply relocation of the sort centres and the rerouting of early morning flights.[73]

Condition 3 (maintain safe and efficient use of the navigable airspace) contains safety and airspace efficiency issues which were not satisfactorily supported by substantial evidence. One aspect was that the Authority's analysis underestimated the potential impact on other airports nearby as well as on the efficiency of the airspace. A full curfew could shorten the already highly constrained airspace.

With its decision of **condition 6** (does not create an undue burden on the national aviation system) the FAA underlined that the night curfew would have a significant adverse effect on the congested Southern California area which in turn would spread throughout the national aviation system.[74]

In conclusion, the application of the Airport Authority was disapproved. Instead of a full curfew alternative measures such as sound attenuation were recommended which showed the most cost-effective impact.

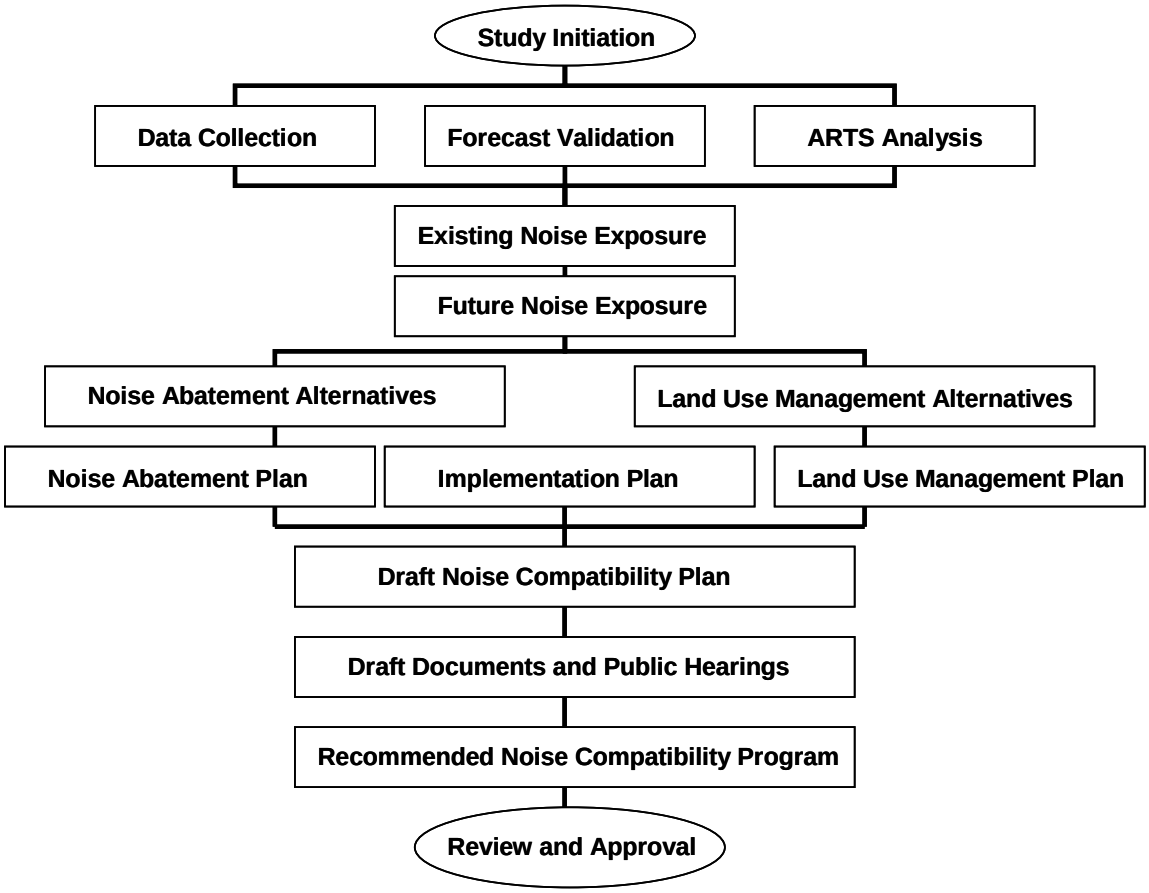
Established prior to ANCA, 14 CFR Part 150 was issued under the authority of ASNA (Aviation Safety and Noise Abatement Act) of 1979 and is another central element in the Federal Aviation Regulation (FAR) of the United States. The aim was to standardise the process of identifying noise and land use incompatibilities and to develop effective abatement strategies. Consequently, Part 150 describes specific procedures, standards and methodologies concerning noise exposure maps and noise compatibility programmes at airports, including the process for evaluating and (dis)approving those programmes (see

[71] cf. FAA (2009b).
[72] cf. FAA (2009b), p. 26.
[73] cf. Ibid., p. 25 et seqq.
[74] cf. Ibid., p. 41.

figure below).[75] The regulations in Part 150 are voluntary, however, the rate of participation is quite high since Federal grants for noise abatement projects can be achieved.

Figure 7: FAR Part 150 Process

Source: FAA (2010c)



With these regulations as described above the United States already integrated all elements of the Balanced Approach into its national aviation noise policy. The acceptance of the ICAO Balanced Approach by the US was communicated in the Advisory Circular of September 2004.[76] In this document the FAA accepts the ICAO Balanced Approach document as additional guidance material. Furthermore, the agency affirms that the procedures and measures identified in this ICAO document are already applied at many US airports.

[75] cf. FAA (2010b).
[76] cf. FAA (2004).

5 Interim conclusion

Aircraft noise and its adverse effects on the people affected have been on the political agenda for several decades already. As a result, a variety of noise mitigation measures have been applied at individual airports worldwide and regulations have been introduced in order to regulate aircraft noise. In order to achieve a harmonised approach on an international level, ICAO Contracting States concluded the Balanced Approach on an airport-by-airport basis with its four principal elements.

(1) **Reduction of noise at source** measures are induced by the adoption and implementation of noise certification standards (ICAO Annex 16). Aircraft today are required to meet standards in Chapter 3 in order to operate at airports worldwide. However, new and re-certification of aircraft require more stringent Chapter 4 standards. This instrument has proven to be one of the most effective means to limit aircraft noise. Though, it is limited to the result of extensive research and development in the fields of aircraft and engine design and implies high investment costs on manufacturers - as well as the airline-side. The replacement of aircraft is extremely cost intensive and, therefore, the lifecycle of an aircraft has to be taken into account. Nowadays most aircraft are in operation for about 25 to 30 years.

(2) **Land-use planning and management**[77] means aiming at harmonising the land use with airport activities. These means are particularly suitable during the design stage of new airports, as a proper planning process can mitigate ex ante the negative impact of aircraft noise on surrounding communities. Also around existing airports positive impacts can be realized by applying land-use measures, in particular, by ensuring that further residential developments around the airport do not endanger the reduction of noise already achieved. Beyond, the conversion of incompatible land-use in defined noise-affected areas can reduce the number the people affected.

(3) **Noise abatement operational procedures** can limit aircraft noise at comparatively low cost by changing the way an aircraft approaches to or departs from a particular airport. Though, this procedure must give priority to safety considerations. Furthermore, several operational procedures constrain on aircraft ground operations.

While in general all pillars of the Balanced Approach should be regarded as of similar importance, (4) **operating restrictions** should be the last resort due to the impacts of operating restrictions. For instance, any form of noise-related bans or operating restrictions of all or certain aircraft types limit the airport capacity and might have a negative impact on the air traffic flow. Beyond, operating restrictions in form of night flight curfews can cause negative economic impacts - not only on a local level but also on a regional and national level.

Although the pillars of the Balanced Approach are not new inventions, the **main innovation of the Balanced Approach** is the **integration** of these pillars and its measures. This ensures that aircraft noise problems at concerned airports are addressed in an environmentally responsive and economically responsible manner. In order to achieve this goal, the selection of potential measures should be based on a **systematic approach**, i.e. on objective and measurable criteria. Such a common approach ensures consistency and transparency of the decision making process by establishing a framework for analysis of costs and benefits for the full array of measures. In addition, it assists all stakeholders in gaining a clear understanding. Nevertheless, flexibility is guaranteed by an **airport-by-**

[77] cf. Ibid, p. 5-1 et seqq.

airport approach which recognizes the unique situation of the airport concerned and allows for a tailored solution based on the specific circumstances. This common framework provides the alignment of competition and ensures certainty and continuity for the organisation of airline networks.

Due to different interpretation, the application of the Balanced Approach differs throughout the world. In the **US** the competencies regarding airport noise-related or capacity-related measures are bundled in one regulative body, the FAA. Thus, decision-making about the implementation of specific measures is regulated on a Federal level reducing the competencies of airports' authority in this respect. On the other hand, the application in **Europe** depends on the different responsibilities between the Member States and the European Union. Therefore, the implementation of the Balanced Approach by Directive 2002/30/EC concerning noise-related operating restrictions is only one instrument which has to interact with several other measures on national level to solve noise problems within the European Union. This shows that the elements and the various measures within the Balanced Approach are existent in the Member States, however, have not yet been implemented in a integrated approach as intended by ICAO. Therefore, it can be concluded that a more systematic approach which encompasses all elements of the Balanced Approach can have a positive influence on noise mitigation. At the same time, it establishes a common EU-wide framework which guarantees transparency and comparability based on measurable criteria.

The different applications and interpretations of the Balanced Approach have been subject to the second stage negotiations concerning a more liberal **Open Skies Agreement** between Europe and the US. While environmental issues were already included in Article 15 of the Air Transport Agreement of the year 2007,[78] noise was not explicitly mentioned however. Therefore, the US-side brought up the aircraft noise issue referring to the need of a comprehensive application of the Balanced Approach. Due to Article 3 of the draft protocol to amend the Air Transport Agreement between the US and the European Community and its Member States, the new Article 15 concerning environmental issues contains reaffirmation to apply the Balanced Approach principle. As a central request, costs and benefits of measures shall be proven.

Therefore, it seems interesting to develop a harmonised structure to weigh the likely costs and benefits of various measures in order to ease decision-making. The following chapter gives an overview of different analyses already existing in this field.

[78] cf. EU (2007).

6 The economic impact of air transport activities

6.1 Introduction

In its main intention the Balanced Approach applies to achieve **optimal environmental benefits** in combination with the postulate to realise this in the most cost-effective manner. That is why the ICAO Assembly of 2001 clearly requires for every airport to combine and assess possible measures planned in the context of the Balanced Approach with a preceding economic analysis.[79] This analysis, may it be done in form of a benefit-cost analysis (CBA), a cost-effectiveness analysis (CEA) or a sensitivity analysis, shall guarantee that best-practice methods are identified and the right approach is chosen which is able to fulfil the different needs of all involved stakeholders. Taking into account the ICAO recommendation, that **operating restrictions** as one of the four elements of the Balanced Approach should in any case only be regarded as **last option** to be realised, an economic analysis safeguards in this context that all measures are weighed carefully against each other and operating restrictions are not chosen prematurely if the objectives can be achieved by alternative means.

Given this relevance of economic analysis within the Balanced Approach, the question must be raised how this concept is realised worldwide and especially in Europe. As the application of Directive 2002/30/EC indicates, many airports in Europe favoured operating restrictions especially with regard to the establishment of curfews and addressed requirements of the Balanced Approach therefore in a very unbalanced manner. This leads to the estimation that **economic impact studies** are finally more or less **not in any case on top of the agenda** when noise issues at airports are discussed and decisions for changes are made. In the US this development differs as the FAA provides much of guidance materials as to how CBAs in the context of airport planning processes can be done and recommends this approach clearly.[80]

Consequently, the following analysis should investigate why it could be useful to implement the Balanced Approach. More or less all existing **economic impact studies** as well as several meta-studies (studies about studies) show a **positive economic impact of airports** for the corresponding region. Therefore, everything should be done to maintain this positive impact. Due to increased environmental awareness the airports are facing the fact that more and more often a reduction of noise is required, particularly when new investments are made at the airport. Finally, there is a need to find a balance to react to environmental requirements and at the same time to avoid a reduction of the positive economic impact the airport has. Under this aspect, the Balanced Approach can help to find a solution.

In order to illustrate how this can be achieved a review of existing studies on economic impacts of air transport activities and airports has been performed in this analysis. The first objective was to critically assess several studies. This should serve as guidance on the benefits as well as on the limits of economic analysis in the air transport sector in general. The second objective was to identify studies which especially focus on the economic impact of night services and freight/express services at airports. This part of the analysis should serve as orientation as to how the economic impact of these actors can be estimated and how their contribution to **economic benefit can be integrated in a CBA** in the context of measures associated with the implementation of the Balanced Approach. When using this two-step analysis it should also reveal the effect the proper application of the Balanced

[79] cf. ICAO (x), p. 12.

[80] Compare the adequate website of the FAA: http://www.faa.gov/airports/central/aip/benefit_cost/.

Approach can have on the economic impact of an airport and the situation for different actors.

6.2 Critical overview of economic impact studies in the air transport system

In the context of the given task, an **extensive desk research** of studies has been done dealing with the economic impact of the air transport system (1) in general, (2) special actors within the system and (3) airports. Finally, three studies were identified which focus on the economic impact of the air transport system or special actors within the system. On the other side, seven studies could be found which deal with the economic impacts around special airports.[81] In total, ten studies were considered, partly performed by scientists, partly by industry and associations. In addition, chapter 6.3 provides an overview of several other studies which particularly deal with the economic impact of air freight services and night flights.

In order to realise a **critical assessment and comparison of all studies**, a criteria catalogue was developed in the next step. Besides the review of the content of all analyses this criteria catalogue investigates whether characterising elements of economic impact studies are used and whether the chosen methodology corresponds to the state of the art in economic research. Therefore, the catalogue was split into two blocks, one dealing with the study methodology, the other dealing with the content of the study and its results on economic impacts.

Table 2: Study Research Parameters

Source: DLR (own illustration).

Analysis of the study content/context
What is the size of the regarded region [local (airport) level, national level, EU level, global level]?
Is a cost-benefit analysis done in the study? In case it is, which variables are used within the analysis?
Are airport noise and its impacts regarded?
Are effects of departing passenger flows considered and e.g. compared to arriving passenger flows in order to complete the picture?
Are direct effects considered and put in a context to other figures (e.g. number of jobs/1000 passengers)?
Are multipliers with regard to induced effects mentioned?
Are multipliers for indirect effects mentioned?
Are multipliers for catalytic effects mentioned?
Is the topic of night/night flights especially regarded within the study?
Is the economic impact of the cargo industry and express carriers regarded and in case it is, to what extent?
Does the study include a total or a partial analysis?

[81] For a concrete overview of all studies please see the appendix.

Analysis of the study methodology
Is the study methodology transparently described? Which methodology was used? Which indicators/variables were used to measure the economic impact within the study? - traffic figures - economic figures (GDP etc.) Which effects were regarded? - direct economic effects - indirect economic effects - induced effects - catalytic effects Is a critical assessment of the chosen methodology been done? In addition, are the limits of an economic analysis mentioned, e.g. with regard to the following points: - problems with regard to measure catalytic effects - problems with regard to the monetisation of figures - data gaps Is there a link to other studies in order to reflect the state of the art in economic research?

As not all studies did exactly cover the same actors within the air transport system or the same geographic area, not all criteria could be analysed in the same way. Some studies deal with different approaches and quantitative measures, which impedes a complete and detailed analysis. Nevertheless, the fields in the table of results given in the appendix could be filled in most cases.[82]

Since the compact overview of the studies is provided in the appendix, the following section should provide a more detailed insight into the different studies, including for each study a summary of the study context, the results and a short critical assessment of the methodology.

6.2.1 Economic impact of the air transport system

ATAG "The economic and social benefits of air transport 2008" (2008)
The study of ATAG (Air Transport Action Group) stresses the importance of **air transport as an innovative industry** that drives economic and social progress. It connects people, countries and cultures, provides access to global markets and generates trade and tourism. Air transport is explained furthermore in its gateway function by forging links between developed and developing nations. In this context, the document of ATAG provides new and updated data on air transport benefits, including the **creation of jobs, the contribution to gross domestic product (GDP) and tourism development** and the provision of humanitarian aid and medical assistance. In order to come to more detailed conclusions global as well as regional figures are given also covering Africa, Asia-Pacific, Europe, the Middle East, Latin America & the Caribbean and North America. All in all, the study summarizes the main aviation-related challenges and opportunities for each of these regions.

In addition, the document is a good orientation how a CBA of air transport activities can be performed as it is based on a study done for ATAG by Oxford Economics and gives essential

[82] See tables 6 und 7 in the appendix.

information on the economic and social impacts of aviation. The only disadvantage is that **environmental impacts** are less regarded.

Kupfer/Lagneaux: "Economic importance of air transport and airport activities in Belgium" (2009)
The study about aviation in Belgium is a publication issued by the Microeconomic Analysis Service of the National Bank of Belgium, in partnership with the Department of Transport and Regional Economics at the University of Antwerp.

It is the outcome of a first research project on the Belgian airports and the Belgian air transport sector. The former relates to the economic activities within the airports of Antwerp, Brussels, Charleroi, Kortrijk, Liège and Ostend, while the latter concentrates on the air transport business as a whole. In the past few years, the **logistics business** has started to play a **significant role** in income development in Belgium, whose economy is to a large extent driven by services. Air transport and airports in particular are driving forces in this context, not only in terms of business generated within the air transport cluster, but also in terms of airports attractiveness.

On world scale an overall growth of cargo and passengers could be observed in the last ten years. However, the air transport sector has undergone a major crisis during the 2001-2003 period, when passenger traffic numbers first fell sharply and then stagnated. Only after 2003 this activity has picked up again and this until the third quarter of 2008. Cargo traffic on its part recovered already in 2002. In Belgium, a similar evolution could be observed. It should be stressed however that between 1997 and 2007 **cargo volumes grew much faster** than passenger traffic did. The rankings of European airports show the importance of cargo traffic for Belgium: In 2006 Brussels, Liège and Ostend-Bruges respectively occupied ranks 6, 8, and 20 in the European cargo airports' top 20, while for passenger airports, Brussels can only be found at the end of the top 20. This shows the differences between both segments.

In order to further analyze the economic impacts generated by this constellation, the authors of the study chose a sectoral approach by focusing for every airport on two major economic activity components: (1) the air transport cluster and (2) other airport-related sectors. In that respect, annual accounts data from the Central Balance Sheet Office were used for the calculation of direct effects, the social balance sheet analysis and the study of financial ratios. Indirect effects have also been estimated on the basis of data from the National Accounts Institute. The time focuses for all this information on 2006.

Referring to this year, the total activities under review – direct and indirect, inside and outside airports – accounted for roughly € 6.2 billion, i.e. **2% of Belgium's GDP** and domestic employment. Considering the direct effects only, these percentages both amounted to 0.8%. The three major airports, i.e. Brussels, Charleroi and Liège, alone account for 95.2% of the direct value added generated by the six airports under review. They represent 0.5% of Belgian GDP and, taking account the indirect effects, 1.1% of the national income. Furthermore, it has to be pointed out, that most Belgian airports are specialized. While the airports of Liège and Ostend focus on air cargo, Charleroi Airport deals mostly with low-cost passenger transport. Moreover, the smaller regional airports like Antwerp and Kortrijk focus on business travel.

To sum up these results, it can be stated that the study gives an idea how direct and indirect economic effects of different air transport activities can be estimated for the local and the national level. This is has to be taken into account in a CBA focusing on the Balanced Approach.

Wittmer et al.: "Luftfahrt im Spannungsfeld von Ökonomie, Ökologie und Gesellschaft" ("Air transport in the area of conflict between economy, environment and society") (2008)

The Swiss study deals with the question of how air transport in the region of Zurich will develop within the next years and if this possible development will be a sustainable one. In order to answer this question the authors decided to rely on a kind of CBA. They compared the **potential development of emissions** (CO_2, NO_x, VOC and noise) and their monetised impacts as costs of air transport development in the vicinity of Zurich airport with **monetised changes in travel time** by possible changes of connectivity. In order to come to realistic assumptions on future developments three different scenarios were regarded.

Within the first scenario the authors assume a status quo development at Zurich airport with 270,000 movements a year according to the situation in 2001. The adequate costs for the climate gas emissions are estimated on the basis of their development in the past and the current market prices for emissions at different emission trading places. The noise costs are based on a two-side approach taking into account planned **noise compensation costs** of Zurich airport for the next years and the number of people which are affected by noise of more than 55 db within the different scenarios. Using this method, the authors come to the conclusion that the local passengers of Zurich airport will fly annually about 86.6 million hours within the **status quo scenario.** This will cause between 323,000 and 404,000 tonnes of gaseous emissions. Accordingly, about 69,000 people will be affected by noise of more than 55 db.[83]

Given the second scenario, assuming that the number of movements will grow by 15% in comparison to the first scenario there will be an overall saving of travel time of 2.6 million hours a year. This corresponds to a saving of CHF 190.6 million travel costs within the same time span. On the other hand, the costs for the external effects range between CHF 13.3 and 18.1 million for gaseous emissions and CHF 16.7 and 39.5 million for noise.[84] Looking at these figures the development within the **growth scenario** can be estimated to be sustainable as the positive economic effects (travel time savings) balance the negative environmental effects by CHF 133 million a year.

With regard to the **third scenario** the authors assumed a **reduction of movements** at Zurich airport by 10% in comparison to the status quo scenario. This led to the result that overall travel time increases by 2.6 million hours each year resulting in CHF 193.3 million additional costs. Meanwhile costs for gaseous emissions decrease between CHF 7.4 and 10 million. Costs for noise are reduced between CHF 14 and 25 million.[85] This is from an economic point of view not efficient as more than CHF 158.3 million additional costs would appear each year at the expense of a sustainable development. Therefore the study comes to the overall conclusion that there is still space for a sustainable growth of Zurich airport and a regulation aiming at a reduction of flights is not wise as this would cause more costs than benefits. In addition, a substitution of some flights by other transport modes with regard to the short-haul distance is also not reasonable as this causes finally more emissions.[86]

When looking at the **methodology** of the analysis it can be stated that it is transparently described with regard to the chosen data, the used models, the metrics and the calculation methods. The authors emphasise in this context that the impact of noise on human health with regard to annoyance is very difficult to estimate, what led them to the decision to

[83] cf. Wittmer et al. (2008), p. 34.
[84] For all concrete figures see Ibid., p. 35.
[85] cf. Ibid., p. 38.
[86] cf. Ibid., p. 44.

exclude costs caused by noise annoyance.[87] Nevertheless, although primarily traffic figures (number of flights and caused emissions) are regarded in the whole analysis the study is based on a very **broad scientific context.** The region of Zurich is focused, but the authors do not exclude a general discussion on the methodology, how positive and negative effects of air transport can be measured in an ecologic and economic context. This part of the study[88] can be seen as good example as it gives hints which indicators could be used in a CBA with regard to noise effects.

The only disadvantage of the complete approach is the fact that the chosen scenarios do not differentiate between airline business models. Movements are generally increasing or decreasing within the three scenarios. The importance of freight services is not stressed and the impact of night flights is completely excluded. Especially with regard to the measurement of noise costs within the study, which represents an innovative and useful approach, the aspect of measuring noise costs for night flights is completely excluded due to simplification reasons.[89] Nevertheless, it can be argued that the whole analysis represents a good advice how noise costs can be measured and put into a context of estimating the impact of regulatory measures. This can also support a CBA in the light of the Balanced Approach.

6.2.2 Airport economic impact studies

Intraplan: "Nachtflugbedarf am Flughafen Berlin Brandenburg International" ("The need for night flights at Berlin Brandenburg International") (2005)
Intraplan's study for Berlin Brandenburg International concerning **night flights** is the second study about BBI which was conducted in order to prove the results of a first study on BBI. A special focus of the Intraplan study is put in this context on an investigation of the operations at core night time and during the border of night time. Furthermore, business segments operating at this time are regarded in order to get an impression of the current demand for night flights at BBI and a forecast for this demand up to 2020.

A first result of the study is that not only airlines determine the demand for night flights on their own. Furthermore, passengers especially in the touristic segment play an important role. For this group it can be very important to arrive at their holiday destination as soon as possible, which increases the demand for night flights. Nevertheless, night flights are also a **necessary precondition for the operations of cargo carriers** and emergency flights. At BBI this leads to the situation that during the time span covered by the study analysis in 2008 42.5 flights on average were performed during night time. 21.6% of all night flights movements were at this time planned for the core night time between 0:00 and 5:00 which corresponds to 9 movements in total.

Furthermore, the biggest share of night flights can be observed in the passenger traffic segment which operates 32.7 movements during an average night, while the cargo segment can be found with 4.9 and "other traffic" with 4.7 movements in this ranking. In addition, the opportunity to fly at night at BBI is also used by operators whose flights are delayed or arrive too early. This mainly refers to the time between 23:00 and 0:00 but there are also additional movements between 0:00 and 5:00 contestable. In this context the study stresses that night flights are of additional importance as they support aircraft operators in optimising their **rotation patterns** in order to improve productivity.

[87] cf. Ibid., p. 5 et seq.
[88] cf. Ibid. p 51 et sqq.
[89] cf. Ibid., p. 31.

As a result, the authors come to the conclusion that the current number of night flights at BBI is below European average. For the year 2020 77 movements per night are forecasted. This is a necessary pre-step for conducting a CBA in the light of the Balanced Approach. Nevertheless, there are only traffic figures given in the study while the direct, indirect and induced effects of night flights as well as environmental effects are not regarded. This shows the **limits of the analysis**.

ECAD: "Strukturbenchmark der Luftverkehrsstandorte VAE und Katar mit der Bundesrepublik Deutschland" ("Structural benchmark of the aviation networks/locations in UAE, Qatar and Germany") (2007)

The above mentioned study by the European Center for Aviation Development (ECAD) is not purely an aviation-related study. It focuses on key elements that are aviation related but primarily the study looks at the general **framework conditions for economic activities** in the countries of the **United Arab Emirates (UAE) and Qatar in relation to the Federal Republic of Germany**. The analysis covers several questions: how GDP has an impact on the projects of these countries, how the laws of each country support or block economic growth in certain sectors and how the relationship between aviation industry and government is in each country.

In this context the **GDP** figures of all three countries are compared in a first step. The UAE have a GDP of € 109,4 billion, while Germany figures a mere of € 2,454 billion. Qatar comes to a GDP of € 27,9 billion. The UAE and Qatar generate most of their revenue from oil exports which are essential for daily operations in most countries, what can lead to the assumption that their **profit margins** are high given the adequate GDP figures. There are also big differences with regard to airport investments remarkable. The study lists about € 16 billion of airport investments for the UAE and € 4,6 billion in Qatar compared to € 8 billion Germany.[90]

Referring to another benchmark, the authors of the study compared the **laws** in the three countries getting to the conclusion that those in the UAE and Qatar are hardly or not comparable with the standards in Germany. Especially the tax laws are not comparable with German standards, while labour rights are very similar with regard to Germany. This is particularly important when looking at this topic in connection with labour costs, which are about 25% less in the UAE and Qatar. This difference can be due to the high GDP in these countries by assuming that both countries are **profit maximisers.** This is also reflected in the investment volume of the UAE of € 16 billion, which was spent for the three airports Dubai International, World Central Airport & Abu Dhabi, as the UAE expects a passenger growth of additional 218 million compared to the existing capacity and is adapting its infrastructure accordingly. Lower labour costs than in Germany allow to realize this plan in such a manner.

Furthermore, the study looks at the decision structure with regard to each country's **flag carrier operations.** The clear advantage in the UAE and Qatar is – according to the authors – that the government is directly involved in the industry including airline activities and airport infrastructure, while in Germany the flag carrier Lufthansa is privatized similar to some airports. Therefore the decision making process in Germany may be more complicated as the government is not as directly involved and conform to market conditions as it can be the case in Qatar and the UAE.

[90] The mentioned figures have to be interpreted carefully and should serve more as an orientation as the volume of large investments in the Gulf region is not easy to determine due to the immense number of large projects which are currently going on there. Therefore an extrapolated figure was used. The similar holds for Germany as only the airports of Frankfurt, Munich and the upcoming BBI airport were regarded within the analysis.

Following this consideration, the main critique point that is raised by the authors at the end of the study refers to the future prospects of the UAE and Qatar for the next years. The authors question, if the successful development of the past will go on despite the financial crisis but also with regard to the aviation sector itself. One indicator for a change is e.g. the fact that the structure of the airspace in the UAE and Qatar appears to be not as well set up for the **capacity** they expect in the next ten years compared to Germany. Another challenge is the rising inflation of the UAE.

To sum up the results of the ECAD study, the added value of the analysis consists of the fact that it gives good hints how an overall political and economic framework of a special state could be included in a CBA taking into account special indicators like national infrastructure investments or legislative conditions.

Klophaus: "Umwegrentabilität des Flughafens Friedrichshafen als Wirtschafts- und Standortfaktor" ("Detour rentability of the airport of Friedrichshafen as important economy and location factor") (2009)
The intention of the study of Professor Klophaus is to establish Friedrichshafen as an important airport for the economy and population within the Bodensee region. In addition, the airport shall serve as **gateway** for incoming tourists.

Concerning this objective, the study analyses the relevance of the airport in order to attract **economic locations of companies** and it shows a perspective for the development of Friedrichshafen airport until 2020 taking into account the fields of economy, population and tourism. Taking this as guideline for further investigations the author comes to the conclusion, that there is a high indirection rentability for Friedrichshafen airport contestable, what means in concrete terms that the airport has the potential to attract companies and passengers for generating positive direct, indirect, induced and catalytic effects (employment + value added) for the region.

IHK (Chamber of Commerce): "Die regionalwirtschaftliche Bedeutung des Dortmund Airport" ("The regional economic impact of Dortmund airport") (2006)
The study "The regional economic impact of Dortmund airport" provides an overview on the development and importance of Dortmund airport for the whole local region. In this context, the authors come to the conclusion that the development of Dortmund airport caused a rising importance of this part of infrastructure within the last years. This was in detail investigated through the conduction of two surveys (passenger-concentrated and company-concentrated) in order to estimate **employment, value added and income effects** caused by the existence of the airport.

As a founding it became obvious that the activities of Dortmund airport created **about 4,200 jobs in 2005**, whereof 3,100 are located in the region. In order to estimate further effects for other geographic levels multipliers were developed. The national multiplier was set at 1.8, which means in concrete that 100 direct jobs at the airport create further 180 jobs at national level. Meanwhile, the regional multiplier of 1.1 foresees 110 jobs at regional level caused by 100 direct jobs at Dortmund airport. Linking these employment figures to economic figures a total **annual value added of € 286 million** results, whereof a share of € 216 million is generated at the regional level. Accordingly, the **total annual gross income** of the mentioned employment activities amounted to € 115 million in 2005. Of this figure, € 88 million are located on the regional level.

To sum up these outcomes of the study it can be stated that Dortmund airport is a catalyst for the economic development of the surrounding region. Given this result it can be

concluded that the study provides a good hint which values – in concrete employment, value added and income – could be included in a CBA in the light of the Balanced Approach. Nevertheless, also here the topics of corresponding **environmental costs** and benefits and the impact of night flights are not covered.

St. Louis Airport: "Airport Business Plan 2002" (2002)
The above mentioned document "Airport Business Plan 2002" analyses the importance and future perspective of St. Louis airport as a regional airport. The authors distinguish between General Aviation and Civil Aviation in order to stress the network importance of both traffic segments coming to the following conclusions on their role in the air transport system.

Table 3: Performance comparison between General Aviation and Commercial Aviation

Source: St. Louis Airport (2002)

	General Aviation	Commercial Aviation
Airports served	19,178	651
Aircraft in use	216,150	18,735
Operations	80 million	24 million
Total hrs flown	28.9 million	13.1 million

The study stresses that there is a special **need for General Aviation** airports as they provide business access to community, sustain local economies, medical transport, law enforcement and fire protection. Without a General Aviation airport there is a loss of economic opportunities thinkable. Business growth and job creation are endangered.

Nevertheless, the distribution and offers of regional airports should be balanced in order to **improve their economic impacts**. In this context the authors refer to the early 1980s in the US when this has not been the case. Many aviation businesses were started at this time in expectation of high growth rates. This led to overcapacity, high competition and a decline in profit margins. Especially suppliers suffered at this time from hard debit obligations and finally failed.

The situation is more balanced today as capacity goes hand in glove with demand. The industry is well positioned and prepared to meet the needs of the expanding market especially by focusing more on business-orientation and customer needs.

Given these market conditions the study concentrates on the **future prospects** of St. Louis airport taking into account the economic conditions in the states of Illinois and Missouri, as the airport is directly located at the boarder between both states. This allows taking some hints for realizing a CBA with regard to regional impacts.

All in all, given these results it can be stated that the case of St. Louis airport – although it does not offer a complete CBA with regard to the aspect of noise problems – is a useful report. It shows how a systematic analysis of the structure and economic strength of an airport region can be conducted and which important measures can be investigated such as **employment and infrastructure development.**

6.3 Critical overview of economic impact studies with regard to air freight/express services and night flight activities

Within the last decades, the business world has dramatically changed. The removal of barriers with regard to international trade, new communication technologies and a general rise in liberalisation on international markets were important drivers for a globalisation process. This allowed many countries to specialise on their core competences in different business sectors and to **decentralise** their **production processes** around the world according to the most cost-effective manner.[91]

Given this development, the **express service business** became simultaneously very important especially within the last twenty years as it supports fast, reliable and on-demand delivery of goods which is essential for the development of **modern economies.** This importance is for example clearly reflected in the business success of the European express industry. Between 1998 and 2003 this business sector grew almost six times faster than the European economy[92] and helped to increase the competitiveness of EU companies. Next to a reliable and retraceable transport service to a broad range of global destinations, which express operators offer, one key factor for this success is next-day delivery. Especially perishable goods like vegetables etc. but also documents, parcels and merchandise goods which decide about getting or losing an order rely on this form of fast transport as no comparable substitute for exactly determined delivery exists.

As this conception clearly demands for air transport express services, the role of air transport has also changed within the last decades. Although, according to OECD estimations only 3% of all **globally traded goods** are currently **transported by air,** this part represents 40% of the value of these goods.[93] Air transport is clearly one core element that allows express and freight services to operate successfully and fulfil their task within the global economy. Nevertheless, air express services are often regarded critically in the light of discussions on aircraft noise. Especially when night flights are necessary to run a global distribution system successfully fears of airport residents about sleep disturbances come up regularly and lead to new campaigns for operating restrictions at airports.

In this context, the Balanced Approach can play an important role to solve possible conflicts as it provides suggestions how to deal with the noise topic in a balanced and cost-effective manner by not favouring operating restrictions in first instance. In order to assume the impact of other measures, **CBAs** can be conducted to find a suitable solution that regards the interest of all involved parties. While this approach is already partly used in the US, parallel work in Europe is hard to find. Therefore, the following section should show a possible way and provide some suggestions how such a study on the economic impact of balanced approach measures can be achieved at European airports taking into account the importance of air transport express services and the **necessity of night flights**.

Oxford Economic Forecasting: "The economic impact of Express Carriers in Europe" (2004)

All in all, several studies could be identified that deal with (1) the economic impact of cargo and freight operators or (2) the topic of night flights. One study, performed in this context is the study "The economic impact of Express Carriers in Europe". It was published by Oxford Economic Forecasting in 2004 and regards the development of the express services

[91] cf. Oxford Economic Forecasting (2004), p. 11.

[92] cf. Ibid., p. 3.

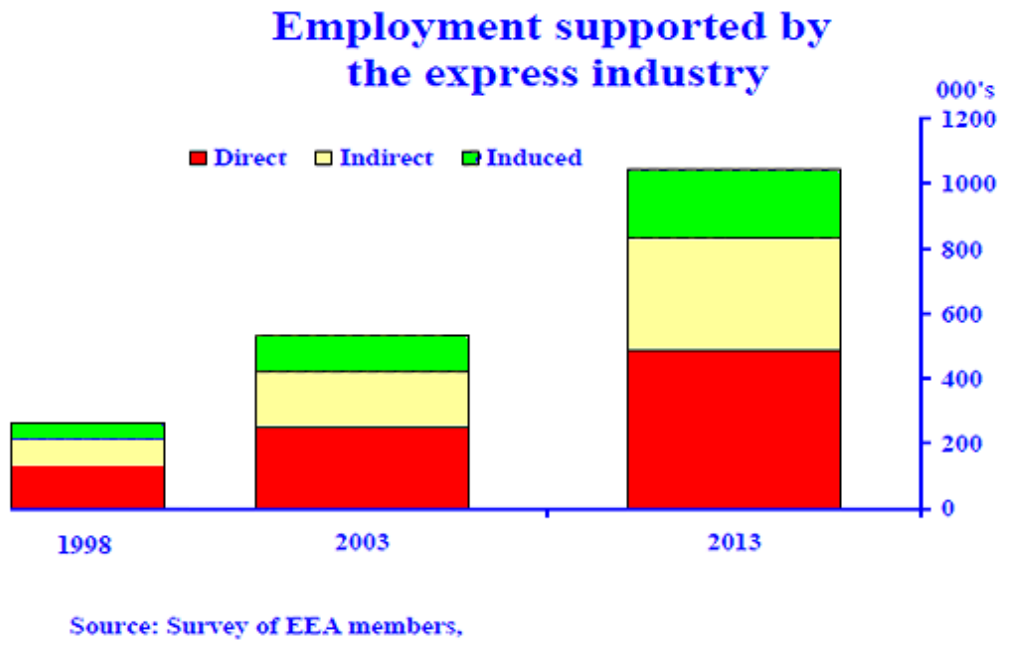
[93] cf. Ibid., p. 6 et seq. See also Eurocontrol (2009), p. 6 where especially the growth prospects if this transport segment are stressed.

business in Europe and its influence on the European economy within the last 20 years by including an outlook into the future. In this context, the study presents an overview on **direct, indirect, induced and catalytic impacts** express services create for the European economy by mainly dealing with jobs and contribution of the express service industry to European GDP (gross domestic product).

The base year of observations to which the study refers to is 2003. In this year, the express industry in Europe offered full-time employment for **250,000 people (direct employment),** supported 175,000 jobs along the transport supply chain (indirect employment) and was partly responsible for the existence of additional 105,000 jobs in other industries which more or less depend on the existence of express services in Europe and the income which direct and indirect employees of the express industry spend in general consumption.[94] Looking at 2013, the study furthermore estimates that the number of direct employees could rise up to **500,000 if business growth were unconstrained.** Additional 500,000 jobs can be attended for indirect and induced employment.[95]

Figure 8: Employment within the express industry

Source: Oxford Economic Forecasting (2004)



Looking at other direct effects, the contribution of the express industry to **European GDP** was estimated to be €10.5 billion in 2003, whereas for the half of this result the four big integrators UPS, FedEx, TNT and DHL can be accounted.[96] In addition, the **revenue** of all actors in the business amounted to €35.5 billion in 2003.[97] For the future, the express industry expects to grow 9% a year on average between 2003 and 2013. While today only

[94] cf. Oxford Economic Forecasting (2004), p. 8 et seq.
[95] cf. Ibid., p. 29.
[96] cf. Ibid, p. 3.
[97] cf. Ibid, p. 14.

3% of the total sales of European companies depend on the express industry this share could be 5% then.[98]

Focusing on possible **catalytic effects** there are also some aspects mentioned in the study. It is described that the express industry indirectly influenced the **export share in GDP** within the European Union in 2003. Within this context the express industry contributes to the welfare of the EU member states by strengthening the competitiveness of European companies on the international markets. Furthermore, instead of mentioning concrete figures concerning catalytic effects, what is in general complicated with regard to the wide range of these effects, only general considerations about the importance of the express industry are made.

It is argued that the express industry contributes to a decrease in sales prices for European products by allowing European companies to broaden their supplier choice with regard to prices and geographic distribution. In addition, it allows companies to outsource bureaucracy, responsibility and costs related to transport issues and, thus, facilitate a **lean, flexible and just-in-time production.**[99] Regarding the contribution to productivity and investments within Europe, it is stressed that the express industry can also help to decrease production costs as it gives especially SMEs (small and medium sized enterprises) the chance to profit from a broader distribution network which they could not build up on their own due to limited resources. In addition, the existence of the express industry guarantees fast delivery of replacement parts and helps to avoid costly production stops.

All these effects were not quantified in the study but they were described in a qualitative manner through interviews with different European companies and case studies in order to illustrate the role of express services for the **competitiveness of the European market.** One part of these case studies focuses on the development of different airports, which serve as main cargo hubs for the four big integrators. By describing the development of Liege, Brussels, Memphis and Louisville within the last decades the clustering effect caused by the choice of headquarters by integrators could be made transparent. Lots of companies followed the integrators in their choice of hubs and settled down at the mentioned airports, creating much direct and indirect employment which is in concrete listed in the case study.[100]

Within the context of the whole study a partial analysis was also performed with regard to next-day delivery options, which can be regarded as part of the discussion concerning the necessity of night flights as next-day delivery means in most cases to transport goods by air over night in order to meet fixed dates. Given this approach, it was asked how the absence of the possibility to realise **next-day delivery** would affect the business of European companies. The result was that more than 10% of all companies which were asked in the UK, Italy, Belgium, Germany, France and Portugal argued that they would try to outsource some business activities if next-day delivery services were no longer available.

Almost half of the asked German companies would also expect a **loss in sales** between 1.7% and 2.6% and an increase in costs of 3% on average. In Italy companies specified that they would probably lose more than 4.5% of their current orders what forces 10% of these companies to relocate their activities somewhere abroad. As a result GDP across Europe could fall by more than € 11 billion a year with different effects on the GDP development in the concerned EU Member States.[101]

[98] cf. Ibid, p. 27.
[99] cf. Ibid, p. 18.
[100] For example 17,250 people are in the meanwhile employed at about 130 companies around Memphis Airport and profit from the good connection into the world offered by FedEx, which based its main headquarters there (cf. Ibid, p. 24).
[101] cf. Ibid, p. 32 et seq.

Although these are just estimations according to different surveys it becomes in this context very clear that next-day delivery is an important **key driver of success and welfare** not only with regard to the express service operators on their own but also with regard to the whole European economy.

To give a short summary of the methodology used in the Oxford Economic Forecasting study, it can be stated that most results are presented in a transparent manner. The study methodology is clearly described. Some data especially with regard to the quantitative parts of the study relies on estimations of the four big integrators while for the catalytic effects different surveys in six EU Member States and in depth-case study interviews were used.[102] This approach provides a concrete measurement of catalytic effects being heavily discussed in the literature and sometimes it is even doubted that they can be measured at all. A rough approximation of possible catalytic effects by individualised case studies and surveys represents in this context therefore a good option to handle these difficulties.

The selection of regarded indicators and variables is less balanced by mainly focusing on economic figures and less on **traffic and performance figures**. The latter could have helped to get a better estimation of the benefits of express services but could also have supported an estimation of the costs caused by external effects (e.g. noise costs) linked to traffic development. In addition, the regarded figures are mainly constrained by only focusing on employment and GDP contribution. Nevertheless, the analysis for the employment indicators is very detailed by including and differentiating direct, indirect and induced employment.

A **critical assessment** of the study methodology and the results is also included in some cases. The study itself stresses the problems of measuring the full impact of catalytic and induced effects and hints at data gaps with regard to the fact that the express industry is not accounted isolated in official national statistics what complicates to estimate its overall benefits. The only aspect which is less discussed is the linkage to the state-of-the-art in scientific economic research. But this can be explained by the fact that the study is more or less an industry study.

To sum up the results of the study analysis, it can be stated that although no CBA was done, the work contains a lot of ideas on how the benefits of the express industry can be estimated and how important the aspect of next-day delivery is within the business. Therefore it can serve as first hint in answering the question what **indicators** can be useful to be integrated in a CBA linked to the Balanced Approach meanwhile considering the special requirements of express and freight service operators.

EUROCONTROL: "Dependent on the Dark: Cargo and other Night Flights in European Airspace" (2009)

The study of EUROCONTROL provides a detailed overview on the characteristics of cargo flights[103] and the characteristics of night flights in order to provide a better understanding of the nature of these operations and their relevance within the air transport system. The focus of the analysis is Europe while the base year refers to 2007. Nevertheless, historical timelines are also included.

One of the main results of the report is that night **flights between 23:00 and 7:00**, although **representing just 10% of total movements** in Europe, form an essential part of air traffic as

[102] cf. Ibid., p. 34.

[103] According to data restrictions belly freight was excluded in the report but all other kinds of cargo (freight and mail excluding stores and baggage) is regarded within the report.

there are some market segments especially vital at this time of the day like the cargo operators. According to this general observation, EUROCONTROL undertook an airport data analysis and found out that some airports within Europe even specialised in this type of business and became typical night airports within the last years. That is how Cologne, Liege or East Midlands, which are not the busiest airports during the day, are highly frequented during the night. They appear in the ranking of total movements at deep night (24:00-5:00) before such big hubs as Amsterdam or Frankfurt.[104]

Table 4: Overview on night flights at European airports

Source: Eurocontrol (2009)

	Deep Night (24 - 05)				Not Deep Night			
	Airport	Airport Name	Mvts per Day[9]	Mvts (%)	Airport	Airport Name	Mvts per Day	Mvts (%)
1	EDDK	KÖLN-BONN	61.6	4.14	LFPG	PARIS CH DE GAULLE	1454.4	2.97
2	LFPG	PARIS CH DE GAULLE	58.9	3.96	EDDF	FRANKFURT MAIN	1322.2	2.70
3	LEMD	MADRID BARAJAS	45.0	3.02	EGLL	LONDON/HEATHROW	1314.1	2.68
4	EBBR	BRUSSELS NATIONAL	44.3	2.98	LEMD	MADRID BARAJAS	1278.7	2.61
5	EBLG	LIÈGE/LIÈGE	44.0	2.96	EHAM	SCHIPHOL AMSTERDAM	1201.3	2.45
6	LGAV	ATHINAI E. VENIZELOS	38.0	2.55	EDDM	MÜNCHEN 2	1170.1	2.39
7	LTBA	ISTANBUL-ATATURK	36.4	2.45	LEBL	BARCELONA	930.9	1.90
8	LEBL	BARCELONA	34.7	2.33	LIRF	ROME FIUMICINO	894.0	1.82
9	EGNX	EAST MIDLANDS	31.5	2.12	LOWW	WIEN SCHWECHAT	748.9	1.53
10	LTAI	ANTALYA	29.4	1.97	LIMC	MILANO MALPENSA	721.1	1.47
11	EHAM	SCHIPHOL AMSTERDAM	28.9	1.95	EGKK	LONDON/GATWICK	709.3	1.45
12	EDDF	FRANKFURT MAIN	25.6	1.72	LSZH	ZURICH	698.5	1.43
13	LIRF	ROME FIUMICINO	23.3	1.57	EKCH	COPENHAGEN KASTRUP	693.4	1.42
14	EGKK	LONDON/GATWICK	22.3	1.50	EBBR	BRUSSELS NATIONAL	659.8	1.35
15	LEPA	PALMA DE MALLORCA	21.7	1.46	LFPO	PARIS ORLY	649.6	1.33
Other	-	-	941.3	63.31	-	-	34552	70.52
Total	-	-	1486.9	100.00	-	-	48998	100.00

This growth is mainly seen at **airports which are less constrained** may it be due to a lack of capacity and slots during the day time or due to operating restrictions. The latter concerns for example London/City airport and Stockholm/Bromma airport where strict curfews were established as both airports lie closely to city centres. London/Heathrow and Munich are unused for 14% of total day hours as a result of different quotas, curfews and aircraft type limitations. In comparison, East Midlands has in general no curfews and handled in 2007 about 32 flights per day during the phase from 24:00 till 5:00.[105]

Concerning further characteristics linked to the aspects of night flights and cargo traffic within Europe, the EUROCONTROL study indicates that there are proportionally **more medium- and long-haul flights** during the night as typical traffic segments. General aviation, regional traffic and military operations with partly shorter operations tend to be underrepresented at this time. It becomes also clearly visible that the most active market segment operating at night is the cargo business. All-cargo flights account for 42% of all flights during the night although especially traditional carriers and LCCs extended their operations within the marginal hours around the night in the last years due to capacity constraints during the day and cost pressures.[106]

With regard to the specific characteristics of cargo flights, the study also examines some typical patterns. First, cargo traffic within Europe is mainly **concentrated among a small**

[104] cf. Eurocontrol (2009), p. 20.
[105] See for the whole section Ibid, p. 28.
[106] cf. Ibid., p. 30 et sqq.

number of European airports. In the deep night period (24:00-5:00) 75% of all-cargo flights involve only 15 airports, what clearly corresponds to the hub-and-spoke system in which cargo and especially express freight streams are normally organised. This links to the second point of concentration which indicates that cargo traffic at airports during the night is normally bundled and arrives and departs in waves in order to optimise delivery processes. This is especially essential for integrators who guarantee fast and reliable next-day deliveries as core part of their business.

Linking to the performance of the cargo transport system in Europe and the ATM aspects, it is revealed that cargo flights are **less delayed** than other flights (only 8% of all-cargo flights compared to 20% within the other business segments).[107] This is probably also due to the fact that cargo flights are overrepresented at night where less traffic allows giving cargo operators more direct routes and does not constrain air space availability as strong as during day time.

Looking at the technical performance, EUROCONTROL did an analysis of the fleet used at night. Obviously, there is a tendency to use more medium- and heavy-weight aircraft at this period which is linked to the strong representation of cargo operators. Nevertheless, the share of heavy aircraft used during this time of the day has decreased within the last years.

Concerning the market situation of the cargo segment, EUROCONTROL gives some hints at the current development although financial figures are missing. Similar to the previous study it is explained that air cargo only accounts for a small share of the transported freight worldwide with regard to weight and volume, but this share is of noticeable value in monetary terms.[108] Air freight services form an essential part of the overall economy what is reflected in the growth rate of this segment. Between 2004 and 2007 the number of cargo flights within Europe increased by 4.9% on average a year. This is a stronger growth than the passenger segment although it is at the same time more dependent on the development of the overall economy.[109]

With regard to the **freight volume** that is handled in Europe, six countries can be mentioned that dominate European cargo operations. Germany handled about 3.4 million tonnes of cargo in 2007, followed by the UK (2.4 mill.), the Netherlands (1.7 mill.), France (1.7 mill.) and Belgium (1.2 mill.). Accordingly, these countries extended by Italy and Luxemburg account for 50% of total daily cargo movements.[110]The mass of cargo in Europe is currently handled by more than 130 freight operators, which own about a third of the world freight fleet and represent a very small but heterogeneous market with some bigger and several smaller players who rely on different business models.[111]

To give a brief summary of the **methodology** used in the EUROCONTROL study, it can be mentioned that the study methodology is clearly described. The authors used a broad range of data, mainly covering a set of flight data which was extracted from IFR flight plans for Europe. Restrictions resulting from the data, specific definitions and possible deformation in the conclusions due to the study approach are transparently described. New developments like the impact of the economic crisis on the statements in the report which were made earlier are also mentioned. The only lack within the study appears with regard to the use of monetary/economic figures, which are more or less completely excluded. As a result, direct, indirect, induced or catalytic effects due to the cargo business or night flights are not

[107] cf. Ibid., p. 66.
[108] cf. Ibid., p. 38.
[109] cf. Ibid., p. 38 et seq.
[110] cf. Ibid., p. 46, p. 52.
[111] cf. Ibid., p. 60.

discussed. Nevertheless, the use of traffic and performance figures linked to the topic is very useful and covers a broad range of aspects.

To sum up the results, the EUROCONTROL study represents a good overview on specific aspects, requirements and importance of the air cargo business in general and the linkage to night flights. It should be considered to be a specific part in a CBA of the Balanced Approach due to the detailed performance figures and the database used in the background.

Merge Global: "End of an era?" (2008)
The study "End of an Era" by the consulting company Merge Global is an industry study which deals especially with the question how **oil availability** and **oil prices** will **affect the air freight business** in the future besides other market conditions.

Three important points were identified for this development. The authors predict a **shrinking market share of air freight** within the freight business in general, as a result of a shift from combined sea/air shipping to ocean services. In addition, they foresee that there will be a change in the demand/supply balance. In the light of rising oil prices many air freight operators will try to adapt to the new conditions with a switch to more fuel-efficient aircraft, while others in the meantime will not be able to finance this. All in all, this will lead to capacity cuts with supply falling faster than demand and giving the residual airlines in the business more power with regard to price-setting[112]. A third change will furthermore consist in a rising market power of integrators. They are already in the possession of a flexible global network including different transport modes and will therefore be able to quickly adapt to new conditions in the business.

The predicted developments are underpinned by different data sources which ran through Merge Global's own "Air Freight Supply and Demand Model". As a result of this process, the authors come to the conclusion that already between 2002 and 2007 a shift from air freight to sea freight happened.[113] Following further results, it can be argued with regard to the future that there are **three options for shippers of perishable goods** when the oil price rises. Some will stop operations at several markets if higher transportation costs will not be covered by their benefits anymore. Another few will stay at their current markets but shift their additional costs to the retailers. A third part will tend to transport their goods in special containers at sea which meet the requirements to deliver these products in due time before the deterioration process starts. All in all, these developments will **strengthen the shift from air as transportation mode to sea**.

With regard to **emergency users** which need ad-hoc deliveries and form 50% of all air freight services users, it can be stated that rising kerosene prices will change the way in which emergency cases are defined. Most probably there will also be a shift to time-definite ocean shipments instead of transportation by air in cases where the transport is not absolutely necessary directly as it does not cause a production stop or a similar reaction. With regard to future demand for air cargo, the authors therefore expect a smaller growth. Until 2017, they estimate a **growth rate** of 4.6% each year for combined intercontinental and interregional cargo demand resulting in different growth rates for different trade flows around the globe.[114] This is a lower rate than the manufacturers' forecasts of Boeing and Airbus assume for the next years.

The development which is presented in the study is based on the estimation that the oil price will rise accordingly. The authors stress that **kerosene** accounts in the meantime for **35-40%**

[112] cf. MergeGlobal (2008), p. 34.
[113] cf. Ibid., p. 40.
[114] cf. Ibid., p. 42.

of the operating costs of passenger and cargo airlines and represents the biggest cost factor. If this development continues Merge Global assumes that there will be capacity cuts in the passenger segment and therefore in the belly freight segment in order to scale down current networks. It is also probable that many freight operators will remove not fuel-efficient aircraft. This will especially be the case when the current global freight fleet is old and many freighters would operate at higher costs between 12 and 23% compared to newer freighters if the oil price rises.[115]

Those who cannot compete with newer aircraft of other operators will then be forced to leave the market. This **strengthens** again – as already discussed – the position of **integrators.** These players which operated more than a quarter of the current global freighter fleet in 2007,[116] will profit from the tendency towards capacity cutbacks and bigger aircraft, as they are already in the possession of a flexible network and can easily gain additional yields for emergency air freight shipments in contrast to other airlines according to the estimation of the authors. Their established and reliable package processes will in the prediction of Merge Global be able to compensate shrinking demand for air freight services. Therefore all in all, the study foresees a switch from air freight to ocean shipment, but also predicts a good position of those air freight operators that will stay in the market as there will be a consolidation that enables them to gain more market power in price-setting.

With regard to the **methodology** used in the study, it can be said that the results are stable. Merge Global is operating with an own "Air Freight Demand and Supply Model", gives definitions of different indicators and the used terminology and relies its expectations on special data concerning GDP, exchange rate and oil price development.[117] Although the study focuses on the global level, estimated growth rates for air cargo are also given for main trade flows around the world and the main result is compared with those of other forecasts in order to create a differentiated picture. The only lack of the analysis is its **missing link to the economic impact** of air freight. Traffic figures for estimating this potential impact can largely be found, but economic figures just appear with regard to GDP development which is an input parameter for the air freight model. Correspondingly, direct, indirect, induced or catalytic effects are excluded, what does not allow a CBA to be conducted. Nevertheless, the cost-side of many freighters with regard to the development of kerosene prices are largely discussed in the study and give a good estimation of how this aspect can influence the market conditions. In fact, the whole study offers a detailed overview of the air freight market, the main operators, their market share and the interfaces with other transport modes. This makes it a useful contribution for a CBA linked to the Balanced Approach.

MPD: "Assessing the economic impact of night flight restrictions" (2007)
The MPD study "Assessing the economic impact of night flight restrictions" was published in 2005 and follows the objective to contribute to a **better application of EU Directive** 2002/30/EC. This is done in the form of a toolkit that allows estimating the economic impact of night flight restrictions[118] at airports and shall serve as guidance material for EU member states.

In order to develop this toolkit the authors of the study prepared in the first instance a detailed analysis of the existing night flight regime in Europe similar to the one of the EUROCONTROL study explained above. The main objective was to identify why night flights are taken out, which airlines are involved and what consequences limitations of night flights

[115] cf. Ibid., p. 34 et seq.

[116] cf. Ibid., p. 44.

[117] cf. Ibid., p. p. 33 et seq., p. 42.

[118] The regarded restrictions in the study are limited to the following ones: 1). limitation on operation of the noisiest aircraft; 2). quotas (sometimes noise-weighted) in terms of activity; 3). night noise surcharges; 4). curfews. Those were selected as they can have a direct effect on the economics of night operations (cf. MPD (2005), p. 36 et seq.)

can have on the existing network. A **first result** found out by the authors from a **set of about 57,000 night flights** at 76 airports[119] within two weeks was that almost half of all night flights are concentrated around twelve airports. In addition, six of those airports indicate a high share of express traffic during the night period which is defined as the time between 23:00 and 7:00 in the study in analogy to EU Directive 2002/30/EC. Nevertheless, short-haul passenger traffic is responsible for the highest share in overall night flights contributing to 47% of the complete market. This is followed by a 20% share of freight, express and mail operators if those are regarded together.[120] Although this allocation pattern should lead to the conclusion that short-haul passenger traffic is the most important segment at night, the authors stress that express carriers are especially relying on night flights as their business model is strongly based on next-day delivery which does not allow much flexibility if one operator wants to stay competitive in the market.

Looking at the results of the study in which the authors consider **potential reactions** of different airline business models **on night flight restrictions** this becomes even clearer. While passenger traffic has still some opportunity to reschedule, freight operators and especially express operators depend on a clearly planned hub-and-spoke system in order to guarantee fast and reliable transport of goods. If increasing stringencies or Quota Count limits are planned at an airport an express carrier can therefore only decide to do a re-equipment or relocation of equipment. In case of a planned jet ban a switch to turboprobs is also possible or the operator can think about re-scheduling or a switch to other transport modes. Nevertheless, if curfews are in discussion and the above mentioned alternatives include too many disadvantages there are only a small number of **options.** If a spoke airport is determined by curfews the express operator can decide to stay there if many aircrafts are involved or he can choose another airport in the region or abandon the market with all additional costs.[121] If a hub airport is subject to curfews there is regularly only the option to relocate and this eventually cross-border. The very detailed planned operations network of an express carrier does not allow enough flexibility to accept a curfew as this would make current operations nearly impossible if no alternative hub airport is chosen.

All in all, these decisions have always an **economic impact** on the concerned airport, its stakeholders and the region and state level where the airport operates. In order to get to an estimation how these impacts can be measured in the most effective manner, the authors of the MPD study performed a **literature review** on analyses that deal with the economic impact of air transport activities in general and the economic impact of night flight restrictions. Within a discussion of more than ten analytical studies of the general topic they finally came to the conclusion that the use of econometric models, as well as the work with “rules of thumb”[122] and multipliers to calculate indirect and induced effects, is essential in order to come to a first consistent picture of economic impacts.

Within their study analysis the authors stay nevertheless **critical**. They argue, for example, that special “rules of thumb” for the airport level should not be regarded as the overall law. If, for example, some flights and passengers are lost at an airport due to new night flight restrictions it can not be said that an adequate number of **jobs** will be cut immediately. Bureaucracy, personnel reduction costs and already calculated overcapacity for some time

[119] These 76 airports can be splitted into the following night flight regimes:
a). 42 airports: no restrictions (23), only noise-related fees (8), or bans on noisier aircraft (11);
b). 11 airports: quota systems of which 9 are working with a “noise budget” or Quota Count systems;
c). 23: full or partial curfew; among those 23 are four city airports (cf. Ibid., p. 3).

[120] cf. Ibid., p. 32 et seq.

[121] cf. Ibid., p. 72 et seq.

[122] “Rules of thumb” allow a first approximation with regard to unknown or uncertain figures, e.g. by estimating the number of jobs created at an airport on the base of a number of passengers (one “rule of thumb” for this case could be that 1 million passengers create 1000 direct jobs). Cf. Ibid., p. 78 for further information.

are reasons that can constrain rational assumptions.[123] In addition, the type of jobs and the definition of **employment** have to be regarded very carefully in economic impact studies. Referring to the BIAC study by Pottelsberghe et al. it becomes clear that there are network effects that influence the employment situation if night flight restrictions are realised. This means e.g. that not only jobs which are linked to night activities have to be regarded in this case. Also jobs which refer to day flights can be endangered when an airline has to stop more than one flight and reorganises its rotation patterns due to night flight restrictions. In addition, jobs at other carriers which only offer feeder flights for those airlines which operate at a night flight restricted airport could be concerned if the latter change some operations. The same holds for jobs at airports at the other side of the route of the night restricted airport and reservation and maintenance staff based near the airport.[124] All these direct jobs have to be taken into account if an estimation of the economic impact shall give a complete picture.

Besides employment effects **monetary values** are also regarded in many studies. A common approach of many authors is that they try to present the value added at an airport generated by different airport operators. This is a good starting point to estimate **economic losses** which could result from a restriction of existing activities. In the DGAC study the authors estimated that freight operators and night flights at **Paris** CDG contribute in the following form to value added:

- 272 tonnes of cargo and mail generate 1 direct, 1 indirect and 1 induced job and additional catalytic effects;
- 24 tonnes of express freight account for the same figures;
- About 12,300 jobs at CDG are created by freight and depend on the period between midnight and 5:00;
- 1 tonne of cargo generates on average a turnover of € 2,700 (general cargo) and € 10,000 (express and mail).

Similarly, economic figures could be identified in the above mentioned BIAC study by Pottelsberghe et al. for **Brussels** airport. DHL's hub function at Brussels contributed in 2003 to the regional and national economy by a direct value added of € 273 million, an indirect value added of € 121 million (multiplier of 0.5) and a catalytic value added of € 600 million (multiplier of 2.18).[125]

Based on these findings and several own **interviews with concerned stakeholders** the authors developed in the following step a **toolkit** that serves as guidance material to provide assistance **how an economic impact study** for measuring the potential **effects of night flight** restrictions can be carried out. This toolkit includes a checklist which shall ensure that all important economic disbenefits that can arise from night flight restrictions are addressed, differentiated by the concerned stakeholders and geographic levels (local, regional, national). The advice of the toolkit is that each stakeholder shall compare the status quo situation (no restrictions) with the minimum-loss strategy he would follow in case of restrictions. Measures for the economic impact of the minimum-loss strategy which the authors proposed are employment development and value added as these two figures are most easily to calculate for the involved geographic levels (for a concrete discussion how these measures should be used in an analysis context see chapter 6.5).

In addition, after a consultation of concerned stakeholders within the form of case studies, the authors elaborated a process for the **application of the toolkit.** They proposed to establish a process with standardised steps. This includes in the first instance that a

[123] cf. Ibid., p. 79.
[124] cf. Ibid., p. 84 et seq.
[125] Induced value added is already included here either in the second or in the third position (cf. Ibid., p. 85).

competent authority is determined which tries to suggest a potential night flight restriction for a concerned airport as detailed as possible and decides also about the flexibility of this restriction.[126] In a second step, this authority has to inform the concerned stakeholders which have to calculate the potential economic effect of the planned restriction especially in terms of direct employment and their financial situation (direct value added) taking into account a forecast of their activities planned within the next 1 ½ years.

For calculating **further indirect and induced effects** in the next step, local, regional and national multipliers have to be defined by academic and research institutions that are reliable enough to add the direct effects. In addition, representative business institutions (chambers of industry and commerce etc.) and touristic representative bodies have to be contacted to estimate the catalytic effects of restrictions on the basis of surveys for the national and the local level. After these working steps it is in the final responsibility of the above mentioned competent authority to do a sense check of all the results by comparing them with official statistics like EUROSTAT NUTS in order to come to plausible conclusions on effects for the regional and national level. This allows in the final step to decide in a balanced and rational manner about a potential night flight restriction and its design.

Taking a look at the **methodology** of the MPD study it can be said that it fulfils most of the given quality criteria in the best way. The used methodology is transparently described by explaining the analysis steps, the used databases and limitations of information and conclusions. The mixture of traffic figures and economic figures which are used in the study context is also very balanced. By using direct, indirect, induced and catalytic effects all import element of CBAs are included and further discussed in an extended literature review which presents a good overview on advantages and disadvantages of special indicators. The same holds for the focused geographic level of the study which allows with local, regional, national and international links a very detailed insight in the difficulties caused by night flight restrictions for the different airline networks. Other important points concern the fact that the study deals **exclusively with the economic impact of night flights** and is therefore also concentrated on noise mitigation problems and the role of EU Directive 2002/30/EC that is already linked to the Balanced Approach.

Another good approach is that the effects of the Directive and **night flight restrictions** are also discussed in the light of the needs and problems of different **airline business models**. The study goes even beyond the scope of air freight operators in general and differs between scheduled freight operators (long-haul/short-haul), charter freight operators, express operators and mail operators. The only disadvantage is that no complete CBA is performed in the study context and the aspect of environmental costs and benefits (e.g. through a monetisation of noise changes by planned night flight restrictions) is excluded. The other problem is that only the fourth pillar of the Balanced Approach – operating restrictions – is regarded what constrains the view of the study. Nevertheless, the analysis provides a very useful, detailed and highly qualitative overview of the potential economic impact of night flight restrictions.

6.4 Recommendations for an economic impact study in the light of the balanced approach

As the study time did not allow to perform an own economic impact study on the measures of the Balanced Approach the following section shall serve to make some general recommendations **how** such an **economic impact study could be done**, which metric

[126] One prominent example when flexibility aspects become important is e.g. the question how delayed flights should be handled in times where a curfew is in operation.

could be used and which problems have to be taken into account in order to come to reasonable results.

Assessment of economic impacts
Given the analysed studies and the economic impact of freight activities and night flights many useful conclusions can be drawn. The studies helped to identify some potential ways how the importance of the express and freight industry and the changes which would result from regulative changes at existing networks can be estimated.

Two types of studies were analysed in Chapter 6.2. The first study type dealt with the **economic impact** of air transport **in general** and gave a good hint how this impact can be measured with regard to different geographic levels (regional, national, European level etc.) and special actors (e.g. the different business models) in the air transport system. The second type focused predominantly at **airports** and provided very useful insight in the micro-level. Finally, both types of regarded studies showed a wide **range of methods** how direct, indirect, induced and catalytic impacts of air transport activities in general or of special actors can be considered in a consistent way. It became clear that measuring employment effects and the GDP contribution as well as value added are the most important indicators in order to deal with these effects.

To sum up the results of the literature review, we prefer a strong linkage to the methodology of the MPD study as its authors already developed an **assessment toolkit** that enables users to better estimate the impacts and economic disbenefits caused by night flight restrictions. This toolkit has the general advantage that it allows to regard several potential designs of restrictions (e.g. constraints with regard to the number of flights, the timing of the flights, the aircrafts that are (not) allowed to be used). Although this still refers only to the fourth pillar of the Balanced Approach many general statements and conclusions of this standard tool can be extracted which also gives hints how the economic benefits/disbenefits of other measures within the Balanced Approach can be estimated.

Table 5: Methodological toolkit within the MPD study

Source: DLR according to MPD (2005)

Areas of usability	**Scope of toolkit (metrics)**	**Geographic coverage**	**Types of Measures**	**Measurement timeframes**	**Use of multipliers**	**Cross-border effects**	**External economic data**
Complete **night curfews**	**direct impacts**: mainly concerning operations at the airport	**local**	employment	"snapshot" approach instead of time series net present value	multipliers should be elaborated on a local base wherever possible	direct cross-border effects should be regarded	comparison to data of EUROSTAT for employment and income development on the local, regional and national level necessary (including differentiation by industries)
Extension of existing night **curfews** up to full eight-hour period, e.g. to 7:00 or from 22:00	**indirect impacts**: affecting the supply chain of airport operations	**regional**	value added according to two methods: a). Production method: gross revenues (turnover) +/- changes of bought-in goods and services b). Income approach: annual wage/salary + changes in annual profit	future values have to be discounted			
Quotas on total number of movements or total number of departures or arrivals; or: reduction in present quotas; or: extension of hours for quotas	**induced impacts**: effects on the economy due to reductions in income of direct and indirect stakeholders	**national**					
Banning of A/C **movements** with noise classification above a fixed level; or: reduction in current imposed maximum noise levels; or: extension of hours during which movements can not take place	**catalytic impacts**: effects on the economy resulting from limiting the wider role of the airport and its operators in improving productivity, investment attractiveness and inbound tourism for the airport region						
Quota Counts, i.e. a count of A/C movements or noise quota according to A/C noise classifications; or: reduction to an existing Quota Count; or: extension of hours for Quota Counts	**effects on airline customers** (travellers, shippers, etc.)	**(cross-border)**					
	Competitive effects of proposed measures						

The big advantage of the toolkit shown in the **table** above is that it covers a wide range of involved stakeholders and the possible effects that can result from operating restrictions linked to night flight activities.[127] The **first column** represents the possible **restriction types** for which the toolkit can be used with regard to assessment purposes. It is shown that a broad range of possible measures is covered reaching from complete curfews to quota solutions or the banning of special aircraft. Nevertheless, it is imaginable that additional measures linked to the three other pillars of the Balanced Approach refill this place as the suggested MPD-methodology how all stakeholders can estimate their economic impact is transferable to other measures, too. A short overview of how this could be done will be explained later on.

Looking at the scope of the toolkit it becomes clear that its **operability** is oriented on a very broad context. The authors prefer the use of indicators measuring the direct, indirect, induced, catalytic and other (wider) economic impacts of night flight restrictions. Regarding the direct impacts they favour the approach that all stakeholders concerned shall report on those by differentiating between:

1. direct impacts that appear at the airport (e.g. direct jobs at the airport),
2. direct impacts that appear in an area 50 km around the airport (circle can be changed in favour of a case-by-case analysis),
3. direct impacts in the local region (to be further determined),
4. country-wide direct impacts,
5. cross-border impacts.

Although the objective of Directive EC 2002/30/EC is not to cover the latter one, a detailed analysis as introduced in this section is very preferable as it supports the claim of a **CBA** to indicate and measure **all possible economic and environmental impacts** in order to come to balanced decisions. Nevertheless, a pre-estimation of the costs and benefits of collecting all this data shall be taken into account in order to check the timeframe stakeholders would need to fulfil this task. The question of the **degree of transparency** is another aspect which also concerns the direct impacts and needs to be addressed here. Data about airline operations linked to freight values, value added from different operations and number of employees, status etc. is normally very confidential data. Especially at an airport where only some players are active it can therefore be expected that these carriers will try to avoid publishing or communicating such data in order to ensure that their competitors do not get insight in their business strategies. Given this constellation it must carefully be determined which data should be collected and in which way anonymity can be ensured.

Looking further at the **indirect, induced and catalytic impacts** for which the concrete definition is given in the table above, the MPD authors suggest that these are estimated on the basis of direct effects by using **suitable multipliers** that extend the conclusions drawn. One example for such an approach is given in the Sleuwaegen study about the development of Brussels airport.[128]

[127] The authors in the MPD study stressed by themselves that an economic measurement is only useful if the “widest extent of economic effects” are measure (cf. MPD (2005), p. 97). The limit is there where effects can only be estimated with high uncertainty as this is not compatible with scientific standards.
[128] cf. Ibid., p. 83.

Table 6: Employment and value added effects at Brussels airport

Source: MPD (2005)

	Jobs		Value added	
Direct	19.9 k	*	€ 1.38 bn	**
Indirect	17.7 k	D x 0.89	€ 1.07 bn	D x 0.77
Induced	9.9 k	D + I x 0.26	€ 0.62 bn	D + I x 0.25
Sub Total	47.5 k	D x 2.39	€ 3.07 bn	D x 2.22
Catalytic	12.7 k***	D + I + I x 0.27	€ 0.79 bn	D + I + I x 0.26
Total	60.2 k	D x 3.02	€ 3.87 bn	D x 2.80

* Total employment on the airport, broken down by industrial classification sector, changes (deltas) being calculated from employment elasticities related to traffic loss or gain.

** Value added is calculated from value added per employee by industrial classification sector, derived from central government company data.

*** Catalyst jobs and value added calculated indepently on a basis of jobs per mppa, and value added per employee, in turn derived from survey data, multiplier derived for illustration only.

The **multipliers** used in the Sleuwaegen study for measuring further effects are nevertheless only estimations and the authors of the MPD study strongly stress the approach to consult several scientific research institutions in order to come to a consensus in the choice of these multipliers as this would reduce uncertainty and help to establish common standards.[129] We strongly prefer the same process as this guarantees that results are comparable. Nevertheless, conditions at several airports can strongly differ and the standard multipliers have probably to be adapted in a case-by-case basis where necessary. The same holds for multipliers that help to estimate the above mentioned effects for the local, the regional and the national level.

The correspondence of the MPD study to the Sleuwaegen report mentioned above is nevertheless broken with regard to the **catalytic effects**. As these effects are most difficult to measure as investment and location decisions of companies are mainly resulting from a number of factors and not only depending on air transport connectivity the authors of the MPD study suggest to rely on a survey-based research on catalytic effects. Nevertheless, they do not foresee to ask all important companies around an airport on the importance of night flights. Instead, they suggest concentrating on only two segments for which night flights can be important: customers in the segment of inbound-tourism and customers that depend on the express industry.[130] As airlines have normally the best information about their customers they are seen as main providers for further contact points to do research on this topic. Nevertheless, data has finally to be checked in comparison to national and regional statistics for quality purposes.

Concerning the **consumer impacts**, which are suggested to be additionally investigated within the context of night flight restrictions, the authors argue that these represent an effect but this effect will not be easy to measure as its part of the catalytic effects. Nevertheless, there should be an awareness that these effects are existent and have to be taken into account. The same holds for competitive effects. Again, the authors see it as part of the concerned airlines' responsibility to address this topic if they see an impact in this field.

Looking at the **geographic coverage** of the toolkit the approach to extend this as wide as possible can be seen as positive for the reasons which were already mentioned. A CBA

[129] For the national level such a multiplier standard can already be estimated. For indirect and induced effects this standard lays between 2.0 and 2.4 (cf. MPD (2005), p. 111.

[130] cf. Ibid., p. 100.

analysis should always aim to cover as many important impacts as possible and quantifiable respectively.

Furthermore, focusing on the suggested measures the authors of the MPD study introduced **employment** and **value added** as most efficient metrics to be regarded in an economic impact analysis linked to night flight restrictions. This is a good choice as this approach is mainly consistent with the results of the other studies reviewed in the previous chapters. Especially employment effects are a good indicator of economic impacts as all airlines regularly collect and update this kind of data as part of their regular business. In addition, employment is the only indicator which is easily quantifiable for all geographic levels and involved stakeholders.[131] In this context further differentiations of employment are conceivable: e.g. passenger-related, cargo-related and aircraft/movement related employment to come to more concrete conclusions.

Nevertheless, the authors of the MPD study also mention some **critical points** linked to the **measure** of jobs. If the number of jobs at an airport should be calculated it is for example important that double-counting is avoided. Double-counting can happen if studies are built upon each other ignoring different methodological approaches or if national statistics with different accounting methods are combined. Another phenomenon is that a night flight at an airport does probably not only create a direct job at this airport but also at the other end of the night flight route. In this case it must be decided – most efficiently in comparison to other studies in order to guarantee standardized approaches – if the latter job is a direct one or an indirect one. In addition, to come back again to the discussion of multipliers, it is very important to know the employment mix of an airport. While one airport offers many direct jobs the other one could rely on a huge amount of subcontractors. In addition, employment figures can vary by seasonality.[132] Therefore, all multipliers have to be chosen with greatest carefulness in consideration of individual conditions.

Focusing on **value added**, the second measure which is preferred in the MPD study, it can be argued that this indicator can easily be calculated for the national level in accordance to official statistics and on the level of the individual stakeholder (e.g. an airline) as each single company normally records and monitors its financial situation very well. Nevertheless, estimating the direct value added for the local level (airport level) can become difficult as airlines normally have another internal cost accounting system. This may only allow estimating the value added within the network linked to different operations and not linked to a special airport.[133] Similar problems appear for the local and the regional level so that value added for this geographic coverage has to be estimated again according to existing statistics for the national and regional level where value added is commonly used as a standardised metric. Following this approach the BIAC Study of Pottelsberghe et al. published the following results for value added creation through the existence of DHL's express hub in Brussels referring to 2002:

- direct value added: € 273 million
- indirect (and probably induced?) value added: € 121 million (using a multiplier of 0.5)
- catalytic value added: € 600 million (using a multiplier of 2.18)134

It is important to stress that in case there is finally no data on value added available GDP can also be used as a **sufficient alternative**. This is a common approach which was followed in

131 cf. Ibid., p. 122.

132 cf. Ibid., p. 79 et seq.

133 cf. Ibid., p. 122.

134 This figure can probable include the subsumised indirect and induced value added. This does not become obvious in the study context (cf. Ibid., p. 85)

the study “The economic impact of express carriers in Europe” of Oxford Economic Forecasting (cf. Chapter 6.3). In addition, there are some other indicators and variables that can contribute to measure economic impacts on different regional levels and also in the context of the Balanced Approach.[135] Nevertheless, these just represent a useful selection from the literature review of analysed economic impact studies as well as general considerations and shall rather be a recommendation for further discussion on the design of an economic impact study in the light of the Balanced Approach than a concrete regulative framework suggestion.

To come back to the table above the MPD study gives some comments concerning the measurement **timeframes** for the different impacts. The authors tend to a “snapshot” approach as the date where a restriction should be put into place is normally known and the current situation is interesting for this plan. Nevertheless, strategic plans of the concerned stakeholders seem to make it reasonable that the time horizon shall be extended in the near future. This is particularly true for the situation of express carriers as those normally operate with a long-term horizon and are forced to make bigger investments at their preferred airports due to the nature of their business. So, if a restriction is planned their economic benefits/disbenefits shall be taken into account including the near future. The only problem in this context is that future values have to be discounted and the choice of the discount factor is problematic due to uncertainty. This is often a point which is criticised regarding CBAs in general and their accuracy.

Relatively clear are the last two components of the toolkit. Besides the local, regional and national level **direct effects on the cross-border level** can surely be taken into account in a CBA. This would e.g. be the case if a freight operator decides not to serve a special route anymore due to new night flight restrictions. In this case, there are potentially direct jobs at the restricted airports which can be cut but also other jobs at the end of the route, which eventually belongs to another country. This effect should be regarded to complete the picture. The same holds for the use of external economic data which should always be integrated in a CBA in order to fill data gaps and to guarantee a quality check on existing results.

Assessment of environmental impacts

The big gap of the MPD study is that it does only provide information how the economic benefits/disbenefits of a regulative measure within the Balanced Approach are regarded. An **inclusion** of the **environmental benefits/disbenefits** which would complete a CBA is missing. Therefore, the following sections shall give some suggestions how this part could be included.

A good hint for this objective gives the study “Luftfahrt im Spannungsfeld von Ökonomie, Ökologie und Gesellschaft” (“Air transport in the area of conflict between economy, environment and society“) by Wittmer et al. (cf. Chapter 6.2.1). The study deals – as already mentioned – with the **environmental impacts at Zurich** airport assuming a different development of movements in the future. In order to come to a comparable base and a useful estimation of the environmental benefits/disbenefits in dependence from traffic development the authors **monetised** these impacts. Noise is regarded in this study separately from other emissions what enables us to present this approach here in the context of the Balanced Approach. Wittmer et al. concentrate – for good reasons – only on the objective impact of aircraft noise on people excluding questions of noise annoyance and a monetisation of this aspect. Taking into consideration that noise annoyance is in general a subjective awareness and hard to measure we strongly recommend a similar approach. This

[135] See the appendix for a list of these measures.

means that noise annoyance should be excluded in an economic impact study in the light of the Balanced Approach.

Nevertheless, the **noise impact** can be addressed in the way that Wittmer et al. suggest. This means a two-step approach dealing, firstly, with the number of people that are affected by noise until a special value is reached. This can be adapted if the Balanced Approach is regarded to other research questions which should be addressed in a CBA. These can include the following ones:

- How many people are in general affected by noise?
- Which measures within the Balanced Approach are useful to reduce this number?
- If a potential measure is already in discussion: How would this measure reduce the number of people affected by noise?

Secondly, Wittmer et al.'s two-step approach focuses on planned **noise compensation costs** at an airport which has additionally to be taken into account in order to estimate monetised noise costs. This aspect is especially very important as it already refers to the Balanced Approach and the three first pillars which deal with noise prevention. Compensation costs can be used as a hint how prevention costs can be calculated.

Given the two important measures – number of noise affected people and noise compensation costs - the final question is which **monetisation methods** are used to finally determine the economic impact behind these metrics. This is not an easy question as the value of environment is hard to estimate and again depends on many factors. Nevertheless, the theoretic literature recommends two approaches in order to come to a monetary approximation of the value of this good. In general, **two concepts for questioning noise** (or by other environmental impacts) affected people can be used. They can be asked for:

- their **"Willingness-to-Accept"** (Question about their preferred compensation price for which they are willing to accept a reduction of environmental quality / quality of life),
- their **"Willingness-to-Pay"** (Question about the payment they would offer in order to gain a higher environmental quality / quality of life).

These two concepts give a first hint for monetising noise impacts or vice versa the environmental benefits which would arise from a noise reduction. Nevertheless, additional studies already exist, which offer some other values to monetise noise and environmental impacts. These measures and the adequate studies are presented in the annex.[136] As the environmental system should nevertheless be regarded as a whole other metrics e.g. for measuring climate effects are also added in the annex in order to complete the picture.

As the already given conclusions are of very general nature the following section shall highlight in brief how a CBA adapted to the four different pillars of the Balanced Approach can be designed. Additional hints are given at problems which could arise within each section.

Recommendations for the design of a CBA addressing the four pillars of the Balanced Approach

a). Reduction of noise at source

The first pillar of the Balanced Approach foresees the "reduction of noise at source". This point mainly focuses on the production or modification of aircraft under the objective to

[136] See table 9 in the appendix.

reduce its noise impact. In addition, fleet and traffic evolution, air traffic management and airport infrastructure are concerned by this approach. As recommended by ICAO all these measures should in any case be taken firstly into account as they represent a solution how **noise problems** can be solved or reduced already **before they appear**. This is not in any case the cheapest but probably a less laborious solution among others.

A CBA linked to this first pillar of the Balanced Approach and focusing on the airport level should first clear what measure is regarded and how far **changes in fleet and traffic evolution,** air traffic management and airport infrastructure are determined. Production costs for less noisier aircraft can be neglected as this is something which concerns more or less manufacturers and not the stakeholders at an airport.

After the formulation of the intended measure, costs and benefits can be calculated. Depending from the measure these can include the following ones.

Costs:

- costs of airline operators for modification of aircraft in order to reduce the noise impact (e.g. addition of winglets, etc.)
- costs of an airline operator for fleet and traffic evolution (e.g. replacement of an aircraft within the existing fleet due to new standards)
- costs for the ATM operator for changing ATM procedures
- costs for the airport operator to change/extend airport infrastructure (e.g. building a new runway in another direction in order to disburden more populated areas within the airport's vicinity and in order to extend capacity at day/night)

Benefits:

- Benefits for the noise-affected population (e.g. to be measured in form of changes of the number of noise affected people by a special noise degree and changes in noise compensation costs e.g. through savings with regard to further sound insulation activities)
- Benefits for the airline operators (e.g. less noise landing charges in case they exist, more capacity if a new runway is built and additional benefits e.g. from trade-off effects including fuel savings if fleet renewals take place)
- Benefits for the airport operator (e.g. less noise compensation costs and less opposition against the airport from the side of airport residents e.g. including a reduction of court cases)

To give a short estimation of the benefits and costs of the measures linked to the first pillar of the Balanced Approach it can be said that they are **not easy to calculate** and always depend on the specific situation of an airport. It is also important to stress that the future development of an airport – including its economic impact and the potential development of environmental impacts – has in this case especially to be taken into account as measures like fleet evolution or the extension of runway capacity are long-term decisions. This demands a careful and detailed analysis of current and future market conditions in order to find the right measure for implementing the Balanced Approach. The advantage of "reduction of noise at source" is nevertheless that the regarded measures concern day flights as well as night flights. Competitive imbalances for airline operators mainly flying at night can be avoided this way.

b). Land-use planning and management

The second pillar of the Balanced Approach, "land-use planning and management" is at first sight a very useful measure as it includes a **prevention method** to keep the number of people affected by airport noise in advance as small as possible. Other measures are therefore more or less not needed anymore. The only problem especially with regard to industrialised and highly populated countries like in Europe is that the infrastructure there has

grown over years in a time where the effect of a continuous growth of air traffic was not rethought in detail. That is why the situation now is that many airports lay in areas of high population density near to bigger cities and **preventive land-use planning** is **not an option** anymore.

The only possible solution are **relocation incentives** for noise-affected residents like it is done in the US and in Europe e.g. at Berlin Brandenburg International.[137] Nevertheless, such projects need a medium-term planning and realisation time, are complex in their nature and often costly. Therefore this approach is mainly interesting for **airports** which expect **a high traffic growth** within the next decades. In case a CBA should be performed in order to analyse such a situation – e.g. a planned relocation measure for airport residents – the following costs and benefits should be taken into account:

Costs:
- Costs for the relocation of airport residents (including planning costs, regulative and advisory costs, current land prices, compensation costs for land and buildings)
- Costs for window and air condition programs
- Costs for airlines caused by higher landing fees / noise surcharges

Benefits:
- Benefits for the noise-affected population (e.g. to be measured in form of changes of the number of noise affected people by a special noise degree and changes in noise compensation costs e.g. through savings with regard to further sound insulation activities). Benefits should also be calculated with regard to future traffic prospects.
- Benefits for the airline operators (e.g. less noise landing charges in case they exist, potentially more operational capacity, planning security etc.)
- Benefits for the airport operator (e.g. less noise compensation costs and less opposition against the airport from the side of airport residents e.g. including a reduction of court cases)

A CBA dealing with **relocation** of airport **residents** should always be based on a traffic forecast as this gives a good hint if such a complex action is justifiable. In addition, questions like who bears the costs have to be taken into account. The question is especially how costs are shared between states and federal states, airports and airlines as this influences the cost-benefit position of each stakeholder and can finally decide about the realisation of such a measure.

c). Noise abatement operational procedures

Noise abatement procedures can for example foresee noise insulation measures at an airport. Other measures include mainly operational processes:
- the use of noise preferential routes/runways
- displaced thresholds
- SID/STAR (Standard Instrument Departure/Standard Terminal Arrival Route) and RNAV (Area Navigation) procedures
- Reduced power/drag and CDA (Continuous Descent Approach)
- Limited engine ground running

All these measures are not preventive ones anymore as noise at source already exists at this moment without the chance to reduce its impact in advance. Nevertheless, noise abatement operational procedures bear the advantage that they do not restrict the full use of all

[137] In case of BBI the town of "Diepensee" had to be relocated. This was indeed a result of the fact that this town laid at the part where the BBI airport was planned to be built and not a result of noise issues. Nevertheless, this decision can serve as a reference case here.

capabilities of modern aircraft and may be possible to realise relatively cheap.[138] In addition they can be used in a flexible and combined manner if rules are formulated in a way that they allow to change these over time.

Within a CBA on noise abatement operational procedures the following costs and benefits should be considered:

Costs:

- Costs for ATM operators (e.g. additional costs that result from new guidance procedures, etc.)
- Costs for airport operators (e.g. resulting from additional infrastructure investments that have to be made for optimising runways, replacing old ground running engines)

Benefits:

- Benefits for the noise-affected population (e.g. to be measured in form of changes of the number of noise affected people by a special noise degree and changes in noise compensation costs e.g. through savings with regard to further sound insulation activities and court laws about noise)

Looking at the comparison above the example shows that noise abatement operational procedures seems to be an **easy, fast and possibly cheap solution** to reduce noise impacts. This is especially the case as noise reduction at source and land-use planning and management are long-term solutions. Operational restrictions also need a longer time and require much regulative efforts until they are finally implemented. Therefore noise abatement operational procedures seem to represent a good alternative to be implemented within the Balanced Approach. Nevertheless, this is finally a decision that should be made on an airport-to-airport base.

d). Operating restrictions on aircraft

The effects of operating restrictions on aircraft or other restrictions were already intensively discussed in the previous sections especially with regard to a performance of a CBA linked to the Balanced Approach. Therefore this topic will not be deeper discussed here again.

e). General recommendation for the use of CBAs in the light of the Balanced Approach

In the previous chapters very detailed information on how a CBA in the light of the Balanced Approach could be designed was given. Nevertheless, as an outcome of our literature review there are also some general aspects which have to be taken into account when Balanced Approach measures and their economic and environmental impact in terms of costs and benefits are regarded. These mainly determine the coverage of CBAs, realisation processes and additional regulative aspects.

First, it is important to stress again that **CBAs** shall in first instance be done on an **airport-to-airport base** in order to reflect special conditions. If different Balanced Approach measures are discussed and regarded at an airport it is e.g. clear that it plays an important role which traffic amount was handled at the airport in the past and which position it has in an existing network. Total curfews are for example for a hub airport a very painful intervention while the effect at a spoke airport tends to be smaller. Nevertheless, the complete network has always to be regarded as a whole. Limiting capacity at the hub airport will also have direct effects on the economic impacts of spokes airport. In the same context changed restrictions at one airport result often in changes of the competitive situation between airports. If there is the danger of huge imbalances or strong beneficiaries for other airports through a specific measure this has to be addressed in a CBA. Nevertheless, customers in the industry around the airport do not often have the choice to change an airport for transporting goods.

[138] cf. ICAO (x).

The same holds for substitution of traffic through other transport modes. If there is a **shift** of traffic between **different transport modes** caused by a noise measure the change of the economic impact of both transport modes has to be analysed. There are additional costs and benefits which can result from traffic shifts especially with regard to the environmental impacts. Another issue which appears in the light of the Balanced Approach is the problem of **capacity** constraints. If an airport has already capacity problems at the day some airline operators switch to the night although they would prefer daytime for their operations. Therefore capacity aspects should be included in a CBA if it should not be risked that a measure is chosen which creates an additional artificial bottleneck of capacity.

Similar considerations concern the general **relation between day and night flights** at an airport. Some of these operations are strongly linked to each other due to different reasons like the improvement of turnaround times. If night flight restrictions are discussed in such a context the potential changes of operations during day time have to be also included in a CBA as such a measure can in case of many airline operators create an imbalance within their complete network and make some operations impossible.

Concerning the implementation of the Balanced Approach on the **European level** there are also some aspects which have to be considered. In fact, decisions of implementing measures in a standardised and reasonable manner become more difficult the more regulative bodies and administrative levels are involved.[139] The similar holds for Germany where besides the federal bodies, regulative bodies at the level of the 16 federal states have additional power to determine about airport operations. The problem is that the process of decision-making becomes very complex within this construction and partly hinders the consistent and coordinated implementation of the Balanced Approach. In addition, the process can still rise in complexity if the EU level is concerned. Another complicated case arouses from the constellation if one **airport in country A** allows full-time operations and the noise resulting from this disturbs **residents** in another **country B** as the airport is located near a border. Such a case is given at Zurich airport where Swiss regulative bodies are always in discussion with their corresponding parties on the German side as German residents feel disturbed by aircraft noise. In fact there are very different interests who are in this case in conflict with each other and such cross-border effects should also be taken into account in a CBA if necessary.

Nevertheless, it is not the only problem for the correct implementation of the Balanced Approach if different **regulative levels** are involved. One sometimes argued complaint of decision makers and especially players from judiciary deciding about noise reduction measures is that in some countries the legislative law is too binding, leaving **too little flexibility** for optimal decisions on an airport-to-airport basis. The other argument is that the stakeholders involved in law cases like airlines and airport operators often miss to illustrate their personal situation, their underlying business models and the necessity for night flights in such a detailed manner that legal law can follow their position. There is a lack of information policy that causes inefficiencies in the current system.[140]

All in all, there are lots of aspects which could be identified that have to be considered when conducting a detailed CBA sufficient for deciding about Balanced Approach measures. Nevertheless, there are still today some inefficiencies in the planning and implementation system which anyhow makes it difficult to find a best-practice solution for each airport. Therefore we hope that the listed arguments can serve as useful inputs for further discussion on the whole topic.

[139] Three administrative levels are e.g. involved in the case of Brussels airport which includes the federal level, Bruxelles-Capitale regionale and Vlaams-Brabant regional (cf. Ibid., p. 84).

[140] The listed aspects in this section result from a juristic conference at the University of Cologne where legal aspects concerning airport noise at night were discussed (Date: 14.04.2010)

6.5 Case study: Brussels airport

Switching from theory to **realistic conditions**, there is in fact some practical evidence that operating restrictions are a very strong regulative measure which can create such a strong negative economic impact that some airline operators are forced to reduce their operations, even in the form of ending a central hub.

The most prominent example which can serve as use case here is **DHL** which relocated its **main express hub** in Europe from Brussels to Leipzig in 2008. DHL's hub was originally located in Brussels since 1985. First considerations about night flight restrictions came up in the mid-1990s with discussions about a possible introduction of a noise quota system. In addition, a **night flight ban** for the time between 1:00 and 5:00 was suggested as result of a proposal of the Belgian transport minister in 2000. This proposal which would have been implemented in 2003 would have highly effected DHL's activities in Brussels as at this time the airline was operating about 35-40 movements a night at Brussels airport. Due to the initiative of the Belgian Prime Minister this plan was finally withdrawn, but the responsible regulative bodies in Belgium – the state, the Flemish government and the city of Brussels[141] – decided to apply other restrictions. One of this was a night limitation up to 25,000 movements per year which was further reduced to 16,000 in the meantime, therein less starts than landings.

During these developments DHL announced in 2003 the intention to **build a super hub** in Europe and informed the Belgian regulative bodies that Brussels airport is first choice for this plan due to the existing large and proven infrastructure the company had already built there. The main requirement of DHL was at this time to get **planning security** about the framework developments in Brussels for several years. This point mainly referred to the situation in 2000 as DHL wanted to make sure that a night flight ban as it was intended at this time would not be implemented suddenly and without negotiations with the relevant stakeholders which would impede almost all activities of a super hub. The lack of negotiations or at least consultations leads to a certain imbalance when facing any new situation.

In the first instance the Belgian federal government appreciated the growth plans but after elections and changes in the government this support was not as strong anymore, which finally led to the situation that the company had to **look for alternatives.** This alternative was found with regard to Leipzig/Halle, which was chosen as new super hub due to "the position of the airport, its proximity to growth markets in Eastern Europe, the long-term planning security with comprehensive authorization for night-time flights, the wealth of motivated and highly qualified locally-based personnel, and impressive infrastructure which allows for a future-oriented combination of the carriers air, road and rail."[142] Although DHL kept a regional hub in Brussels, this decision led to the loss of about **1,500 jobs** in Brussels when DHL decided to go to Leipzig. Roughly about one third of the aircraft remained whereas two thirds moved to Leipzig/Halle Airport. So, whereas DHL represented a large amount of cargo traffic at Brussels airport, this is now reduced tremendously.

This example shows that planning security, as it can be guaranteed by the Balanced Approach if used in a proper way, is a very important factor for airlines' location decisions and accordingly the prosperity and the jobs which are created in a special region. Referring

[141] It has to be mentioned that Brussels airport is in general in the competency of the federal government, but environmental restrictions are allowed to be introduced by the Flemish government. Especially in the case of conflicting political parties this might lead to unstable planning conditions.
[142] cf. DHL (2009), p. 16.

to an interview with DHL[143] the super hub location decision for Leipzig was not resulting directly from the introduction of night flight restrictions at Brussels airport, but from the lack of planning security. A **stable long-term framework**, which facilitates to realise investments with a focus up to 40 years was not foreseeable. In addition, the complex political institutional arrangement integrating three regulative bodies which are all involved in airport planning and change regularly depending on the outcome of elections gave additional uncertainty.

Nevertheless, there are also differences depending on the airport. In Liege, the situation is for example quite different. At this airport, which was formerly used as a military airport and where now TNT operates its main European hub, land-use planning was used very successfully to avoid the annoyance about aircraft noise in advance of the introduction of civil flights. Currently, operating restrictions at this airport are limited and the tremendous amount of investments in the last years could be executed under high planning security for the investors, be it the airline itself or the airport operator. That is why **Liege** is often mentioned as a **best practice example** in the light of the Balanced Approach.

[143] All of the following statements and the whole background information provided in this chapter result from an interview between DLR and DHL on June 8th 2010.

7 Interim Conclusion

The previous chapter provided an extended overview on the economic impact of **air transport activities**. It became clear that those activities **contribute to** a large extent to the **prosperity** of a special region by providing employment and increasing the overall GDP. As part of this economic system, cargo and express operators fulfil a special role in this framework by transporting goods in a fast, safe and reliable way in order to support international trade. A necessary requirement to guarantee these services is the establishment of a global network and the opportunity for night flights to optimise the logistic processes in the background and make all operations as effective as possible.

Given these conditions, **operating restrictions** which often aim at night flights can have a huge impact on the activities of airlines and especially those of cargo and express operators up to the state that their business can not be effectively run anymore. This is especially the case if operating restrictions at airports are realised arbitrary and in the short-term, which might have **negative impacts** also on the prosperity of a region in terms of job and income losses. Therefore it is, as also recommended in the Balanced Approach, mandatory that all intended measures to reduce airport noise are investigated with regard to their usefulness and their influence on all concerned stakeholders by a CBA.

Nevertheless, although this is already partly done at the airports within Europe, a failure of the airport operators and the political regulators is still that often only special measures are regarded in an isolated way. Thereby it is forgotten that the effectiveness of the Balanced Approach strongly depends on a combination of the four pillars and amongst those especially of the first three ones as they are most appropriate to avoid noise problems in advance due to their preventive function. This approach is – besides by the EU – also strongly recommended in the scientific literature by hinting at the fact the Balanced Approach can in times of growing air transport only be effective if noise reduction is realised in a manifold manner.[144] This includes always a **coordinated, systematic and long-term oriented focus** on possible measures while on the other side, it excludes at the same time a spontaneous, only politically determined and arbitrary approach which would give no stakeholder – either airport neighbours, airport operators or the airline industry – the **long-term planning stability** that is needed to improve the current system and to optimise the economic outcome under respect of ecological restrictions.

[144] cf. Upham (2003), p. 106 et seq.

8 Conclusions

Aircraft noise with its adverse environmental effects is one of the major environmental issues that airports face nowadays. Noise annoyance caused by a constant growing air transport system arouses public concerns and community opposition in the vicinity of noise-affected airports worldwide. In order to achieve a harmonised approach on an international level, ICAO Contracting States concluded the **Balanced Approach** on an airport-by-airport basis with its **four pillars**: (1) reduction of noise at source, (2) land-use planning and management, (3) noise abatement operational procedures and (4) operating restrictions. The main innovation of the Balanced Approach lies in the integration of the different elements to ensure that aircraft noise problems at concerned airports are addressed in an environmentally responsive and economically responsible manner. This framework provides the alignment of competition and ensures certainty and continuity for the organisation of airline networks. Although noise mitigation instruments have been applied at various airports worldwide, the experience shows that the interpretation and the application of the Balanced Approach might differ significantly. Therefore, stress was laid to base the selection of potential noise mitigation measures on a systematic and encompassing approach. This ensures that the set of measures selected is well-balanced taking into account all potential options for the concerned airport.

While in general all pillars of the Balanced Approach should be regarded as of similar importance, **operating restrictions** should be **last resort**. Positive impacts at low cost can be achieved by a comprehensive land-use planning and the introduction of noise abatement operational procedures while any form of noise-related bans or limitations in the operations of aircraft limits the capacity of an airport and might entail **negative impact on the air traffic flow**. Furthermore, operating restrictions in form of night flight restrictions can cause significant negative economic impacts not only on a local level but also on a regional and national level. Various airline business models depend on night flights. In particular for cargo airlines and integrators which offer express air freight, night time operations are vital, as well as for the industries using their services. The business success of these segments and the industries which rely on these services depend to a great extent on a well organised and complex network. Especially night flights are essential within this framework in order to guarantee fast, reliable and cost-efficient overnight transport of goods worldwide.

Our study analysis has shown that it is for this reason very important, that successfully established transportation networks can operate for several years without deeper regulative intervention changes like in the form of operating restrictions as there is not much flexibility to change existing networks and adapt to new market conditions. This holds especially for the case when a strong regulative measure like night curfews at an airport is intended, which leave especially for freight operators and express services often the only possibility to abandon operations completely or to switch to another location to the price of **sunk costs.** A prominent example is DHL and the relocation of its European hub from Brussels to Leipzig/Halle in 2008 due to the lack of planning security.

Nevertheless, the population around airports' vicinities has to be protected from increasing aircraft noise. In order to solve this conflict the ICAO has already developed a good solution. The Balanced Approach with its four pillars – as described above – was chosen to reconcile the different interests in order to find the most suitable solution on an **airport-to-airport basis.**

This process includes that a **CBA** is done for every planned measure in the light of the Balanced Approach, what shall guarantee to find the most cost-effective and most efficient

option to handle noise problems correctly. After our extended literature review we regard this as essential requirement for the success of the Balanced Approach if its measures should be established at an airport in the intended manner. Nevertheless, the result of the study review shows that in practice there still exist some aspects which could hinder a correct implementation especially with regard to European airports. Therefore we identified some potential improvement points resulting in the following recommendations:

- If measures are planned at an airport, **all** of the four **pillars** of the Balanced Approach should be regarded, especially by taking into account a preference of the first three ones against the fourth pillar of operating restrictions. The study analysis tends to show that regarding the first three pillars can already have a positive impact at lower cost as the fourth pillar can result in high economic disadvantages especially when an airport has a special traffic mix with operators that are very sensitive to operating restrictions (e.g. express services, touristic flights).[145]
- For every intended measure linked to the four pillars a CBA should be undertaken in order to develop a set of alternatives of which the best one or a combination should be chosen.
- The CBA should take the situation of all concerned stakeholders into account.
- Furthermore, the CBA should include monetised environmental benefits/disbenefits (with regard to noise) and monetised **economic benefits/disbenefits** (with regard to traffic figures/performance figures) which have to be compared to each other.
- With regard to the economic benefits/disbenefits it is very important that established and **proven scientific metrics** (e.g. employment, value added, and contribution to GDP) are used in order to estimate such impacts correctly. This facilitates comparisons between airports. In this context it is also very important that a common methodology as it was already initially developed in the MPD study[146] with a special toolkit is improved and commonly used within the EU. The FAA can serve as a good reference case providing detailed information on CBA conduction and common standards.[147]
- Considering the postulate of the Balanced Approach to find adequate measures on an airport-to-airport basis it is also essential to regard the traffic mix at each airport separately and in detail. The literature study had shown that especially with regard to night flights there are big differences between all airline operators. For each traffic segment the night and the core time of night fulfils other functions and is more or less important. To lose sight of this fact can have the result that the wrong alternative in implementing Balanced Approach measures is chosen.
- In addition, it is important that **future plans** of the concerned stakeholders up to two years are taken into account in a CBA of intended changes compared to an existing regime. This gives stakeholders the chance to address economic disadvantages they would gain due to a loss of planning security if they have to adapt their business strategy to changes. In addition, every CBA should be based on a traffic forecast in order to find the right CBA measure for a long-term time horizon as this gives additional planning security to all involved stakeholders.
- In order to gain the best qualitative and most reliable data as base for decisions the cooperation and **transparency** of all involved stakeholders is a necessary prerequisite. In the same time it must be guaranteed that anonymity of the data is

[145] This is also reflected in the DHL example. The relocation of DHL from Brussels to Leipzig led to job losses which weakened the local, regional and national economy also in terms of value added. In contrast, a measure such as a stronger implementation of CDA procedures – belonging to the third pillar of the Balanced Approach – can result in an increase of complexity in organisational processes but does not affect automatically the economic side such as strong operating restrictions do.

[146] cf. MPD (2005).

[147] Compare the adequate website of the FAA: http://www.faa.gov/airports/central/aip/benefit_cost/.

taken care of as especially between airline operators competitive disadvantages can arise if confidential information becomes publicly available.

All in all, these are first considerations how the current handling of the Balanced Approach framework especially with regard to CBAs could be improved.

9 Annex

9.1 Annex of the study results

Table 7: Classification of Boeing noise database according to the Balanced Approach

Source: DLR (own categorisation based on ICAO (2004) and Boeing (2010))

ICAO elements	Abbreviation	Description
Reduction of Noise at Source		
Land-Use Planning	NOISE Chrgs	Noise Charges
Noise Abatement Procedures	NAP	Noise Abatement Procedures
	Pref Rwys	Preferential Runways used to reduce noise exposure in certain areas
	APU	Auxiliary Power Unit Operating Restrictions (Limited Ground Operations)
	RUN-UPS	Engine Run-up Restrictions (Limited Ground Operations)
Operating Restrictions	Curfew	Limiting Operations During a Certain Period of Time (Noise Related Restrictions of Traffic)
	Quotas	Noise/Operating Quota (Noise Related Restrictions of Traffic)
	NOISE BUD	Total/Partial Noise Budget for the Respective Airport (Noise Related Traffic Restrictions)
	NOISE Limits	Noise Level Limits
	Stg3-Ch3 Rest	Stage 3 / Chapter 3 Aircraft Operating Restriction (Noise Related Traffic Restrictions)

Table 8: Results air transport studies analysis

Source: DLR

Research parameter	ATAG (2008)	Eurocontrol	Kupfer_LV in Belgien
Analysis of the study content/context			
1. What is the size of the regarded region [local (airport) level, national level, EU level, global level]?	Global Level	Europe, but divided in Acc-10 and EU 15	National/regional level
2. Is a cost-benefit analysis done in the study? In case it is, which variables are used within the analysis?		-	-
3. Are airport noise and its impacts regarded?	It is just mentioned, that in last 40 years the noise level has been reduced by 20 db (equal to 75% reduction?)	airport noise is mentioned as a result of the growth and expansion of the industry. But no further discussions were made.	-
4. Are effects of departing passenger flows considered and e.g. compared to arriving passenger flows in order to complete the picture?	No	Yes, to show who of the two groups spends more and where	-
5. Are direct effects considered and put in a context to other figures ?	toursim-related employment supported by air, splitting up the employees in effect groups	Yes e.g. percentage of people employed in the aviation sector in Europe	-
6. Are multiplicators with regard to induced effects mentioned?	2.9 Mio. Jobs hav been created and how much they contribute to the global GDP	No	-
7. Are multiplicators for indirect effects mentioned?	6.3 Mio. Jobs hav been created and how much they contribute to the global GDP	No	-
8. Are multiplicators for catalytic effects mentioned?	17.1 Mio. Jobs and their impact on world trade, tourism and productivity	Maybe	-
9. Is the topic of night/night flights especially regarded within the study?	No	No explicit topic just mentioned as scaling up passenger volumes for Belgium	-
10. Is the economic impact of the cargo industry and express carriers regarded and in case it is, to what extent?	No	It is shown, that European air cargo is linked to the size of direct catalytic effects of air transport	-
11. Does the study include a total or a partial analysis?	Only partial because negative effects are excluded	Total analysis	-

Research parameter	ATAG (2008)	Eurocontrol	Kupfer_LV in Belgien
Analysis of the study methodology			
1. Is the study methodology transparently described?	No study methodology described	Yes	Yes
2. Which methodology was used?	no specific methodology	Standard methodology	-measuring economic impact in terms of direct and indirect value and employment
3. Which indicators/variables were used to measure the economic impact within the study? - traffic figures - economic figures (GDP etc.)	traffic figures: -Number of Passenger per year -air freight as a percentage of overall transportation of goods -Percentage of International tourist travelling via air economic figures: -aviation as a percentage of GDP - average growth of the aviation industry	traffic figures: -Average ratio of overnight arrivals & total arrivals -Number of passengers (airports,airlines) economic figures: -GDP -all imports and exports carried by air - ONS International Passenger Survey data	traffic figures: - economic figures: -Value added at current prices - Salaried employment -Investetment in current prices -social balance sheet
4. Which effects were regarded? (direct,indirect,induced,catlytic)	direct effects (5.5 Mio. Jobs) indirect effects (6.3 Mio. Jobs) induced effects (2.9 Mio. Jobs) catalytic effects (17.1 Mio. Jobs)	In particular catalytic effects	indirect effects induced effects catalytic effects
5. Is a critical assessment of the chosen methodology been done?	No		-
6. Is there a link to other studies and accordingly, is the study described in the light of a broader research context in order to reflect the state of the art in economic research?	The study is especially linked to another study by Oxford Economics on which the brochure of ATAG is based on	Study is linked to other studies by using figures, results and/or summaries of them to underline different facts (e.g. ACI Europe Study)	-

Table 9: Results airport studies analysis

Source: DLR

Research parameter	BAUM Schönefeld	BBI Nachtflugbedarf	ECAD	Studie Friedrichshafen	IHK Dortmund	St. Louis Airport
Analysis of the study content/context						
1. What is the size of the regarded region [local (airport) level, national level, EU level, global level]?	local level	local level	National and local level	Regional level	Regional level	local/regional level
2. Is a cost-benefit analysis done in the study? In case it is, which variables are used within the analysis?		No	Yes, relative turnaround costs of a A340-300 in the UAE to Germany	measuring of fiscal effects by comparing public spending with public earnings	-	No
3. Are airport noise and its impacts regarded?		No	Yes, it is regarded as a comparison of the cost that it creates in Germany and the UAE but not its implications	Impacts of an introduction of a new flight noise law considered as a risk for the airport	No	No
4. Are effects of departing passenger flows considered and e.g. compared to arriving passenger flows in order to complete the picture?	Yes	No	-	Origin of outgoing and destination of incoming passengers are considered	Comparison of purchasing power of incoming and outgoing	No
5. Are direct effects considered and put in a context to other figures ?	Yes they are considered but not in a context	No	No	No	No	Direct effects are mentioned but not put in a context
6. Are multiplicators with regard to induced effects mentioned?	No	No	Yes and No. The effects can be implied after reading the corresponding parts and figures	No	-	no
7. Are multiplicators for indirect effects mentioned?	No	No	No	No	-	no
8. Are multiplicators for catalytic effects mentioned?	No	No	Yes. They are considered throughout the prognosis for the capacity of the year 2020. Especially in the form that through the increase in PAX number and the renewal of the airports their capacity will be maximized.	No	-	no
9. Is the topic of night/night flights especially regarded within the study?	No	Yes	No	Impacts of an introduction of a new flight noise law (including Night protection zones) considered as a risk for the airport	No	no
10. Is the economic impact of the cargo industry and express carriers regarded and in case it is, to what extent?	No	Just mentioned, what percentage of night flights is used by cargo	No	No	The cargo industry has a yearly storage capacity of 10.000t and had a cargo handling vol. of 7.300t	no
11. Does the study include a total or a partial analysis?	_	_	Overly based on statistics and trends of how the Airports plan to adapt in the near future.	Anlysis of economic relevance of the airport FDH and its persepctives for 2020	-	_

Research parameter	BAUM Schönefeld	BBI Nachtflugbedarf	ECAD	Studie Friedrichshafen	IHK Dortmund	St. Louis Airport
Analysis of the study methodology						
1. Is the study methodology transparently described?			No, one cannot initially see what methodology is used in the study	Yes	Yes	Not precisely mentioned
2. Which methodology was used?			None could be identified correctly	-	data collecting thru two surveys at the airport and the Statistische Bundesamt und dem Landesamt für Datenverarbeitung	- Comparison of general aviation and commercial aviation - Explanation of the importance of GA- and CA- Airports - Analysis of the geographic region - Analysis of economic status quo and future outlook/trend in that region
3. Which indicators/variables were used to measure the economic impact within the study? - traffic figures - economic figures (GDP etc.)	traffic figures: - development of air traffic	traffic figures: - differentiation between passenger traffic, cargo and miscellaneous as percentage of night flights	traffic figures: -Passenger numbers - expected numbers for the next 10 years -turnaround costs	traffic figures: -Passenger numbers -flight movements -forecasted air traffic growth -etc.	traffic figures: -several figures shown in graphs and tables	traffic figures: - airports served -Operations -Total hrs flown
	economic figures: - labor force and Number of unemployed - income per capita	economic figures:	economic figures: -GDP	economic figures: -Number of employed -Gross value -salaries and wages -etc.	economic figures: -GDP etc.	economic figures: Mo/IL:Gross State product, Total population,Nonfarm employment, Unemployment,Labor force,Total personal income, income per capita,median existing home price, exported products and services
4. Which effects were regarded? (direct,indirect,induced,catlytic)	direct effects		-	direct effects (671 Jobs, production value: 76.7 Mio €, Gross value: 32.2 Mio €, salaries and wages: 16.2 Mio. €)	direct effects	direct effects
	indirect effects		-	indirect effects and induced effects (915 Jobs, production value: 107.3 Mio €, Gross value: 53.3 Mio €, salaries and wages: 23.5 Mio. €)	indirect effects	indirect effects
	induced effects		-	catalytic effects (326 Jobs, production value: 16.4 Mio €, Gross value: 9.1 Mio €, salaries and wages: 4.4 Mio. €)	induced effects	induced effect (construction of Regional Airport business park)
			-	fiscal effects (21,9 Mio. €)	catalytic effects	catalytic effects
5. Is a critical assessment of the chosen methodology been done?		No	No	No	-	No
6. Is there a link to other studies and accordingly, is the study described in the light of a broader research context in order to reflect the state of the art in economic research?		Study is linked to a former study	No	No	results compared with other studies	No

Table 10: Measurement framework for economic impacts

Source: Wittmer et al. (2008).

Regarded Dimension	Description/Measurement of the Dimension	Source
Output/Production	Information for selected airports: number of runways, growth of the departure routes, number of passengers, number of movements	OEF 1999, 2006
	Number of movements differentiated by traffic type, share of freight and mail	INFRAS 2006
Efficiency/Cost-effectiveness	Survey about the importance of the air transport industry for other parts of economy: importance of air transport activities for management organisations, implications of the usefulness to serve bigger markets, importance of passenger transport for organisations, effects of a reduction of air transport service	OEF 1999, 2006
Rentability	Gains and losses for the whole air transport industry (differentiated by airports and airlines): traffic, trade, complete operational costs, interest rates, other costs, extraordinary income, taxes, dividends	CAA Airline Statistics & CRI, University of Bath "Airport Statistics 2004/2005"
Taxes/State Income	Paid Taxes and insurance fees from airlines and airports in the UK: income tax of the aviation industry, national insurance fee of the aviation industry, co-operational tax income of airport and airline, passenger taxes	OEF 1999, 2006
	Net surplus per 1000 rkm (taxes and user charges per 1000 revenue-kilometre - infrastructure costs per 1000 rkm) for flights and railway trips in Germany, UK and France	"Comparison of Taxation and Subsidy for Transport Modes around the World", Mott Mac Donald, 2005
Value Added/ Additional Value Added	Additional value added per capita concerning jobs in the air transport industry	York Aviation 2004
	Additional value added per employee in the UK (differentiated by air transport, supporting services, aviation industry and average within the whole economy segment)	OEF 1999, 2006
	Value added of the flight industry differentiated by: air transport, supporting services, other parts of aviation (determination according to prices and volumes)	OEF 1999, 2006
	Share of the aviation industry in national GDP (given in %)	OEF 1999, 2006

	Survey about estimation on: 1) the share of sales which is dependent from air transport services; 2) the development of the dependence from air transport within the next 10 years	OEF 1999, 2006
	Value added of the Swiss air transport industry in 2004 (in million CHF); direct (airport-related) and indirect (supplier-related) effect for Zurich and other national airports	INFRAS 2006
	Value added of the Swiss air transport industry in 2004 (in million CHF), induced and passenger-related catalytic effects, subtotal of all effects	INFRAS 2006
	Estimation for different regions: 1) value for the Dutch economy that is generated at Schiphol airport; 2) Frankfurt airport: change of total gross value added of the region Hessen in case of constrained development (Mio DM); 3) worldwide effects of the airports in Paris on the economy of the region "Ile de France"; 4) additional value added through the operations of different airports (Wien, Zurich, Schiphol, Tallin, Swiss airports before grounding)	York Aviation 2004
	Share of the aviation industry in Europe's and global GDP (direct, indirect and induced)	ATAG 2008
Advantages for the Supply/Market Side	Share of air freight in total UK freight (in %)	OEF 1999, 2006
	Import/export value of air freight	OEF 1999, 2006
	Complete volume of air freight at UK airports (in tonnes)	OEF 1999, 2006
	Survey about the importance of air transport services for companies in the area of marketing & sales, customer contact & support, efficiency of production and supplying methods, opportunity to serve bigger markets	OEF 1999, 2006
Employment/Jobs	Direct employment in the aviation industry and affiliated sectors, indirect employment, induced employment	OEF 1999, 2006
	Jobs in air transport (VZÄ) in Switzerland (direct, indirect, and passenger-sided induced effect)	INFRAS 2006
	Employment created by the aviation industry (direct, indirect, induced) for Europe and worldwide	ATAG 2008

	Estimation on employment changes: 1) Frankfurt airport, change of total gross value of the region Hessen in case of constrained development; 2) worldwide effects of the airports in Paris on the economy of the region "Ile de France"; 3) direct employment at airports which belong to ACI (differentiated by special areas)	York Aviation 2004
	Indirect (supplier), induced (by spendings of direct and indirect employees caused) jobs per 1000 on-site jobs at European airports	York Aviation 2004
Export/Import and International Trade	export/import balance sheet of the air transport industry	OEF 1999, 2006
	Air freight exports in Switzerland/Import value and weight	INFRAS 2006
	Qualitative importance of the aviation industry for other Swiss sectors (traffic intensity in production, export orientation, importance of international connectivity, share in national GDP 2001, general conclusion), in concrete chemistry, credit institutions, engineering, insurance companies	INFRAS 2006
	Share of air freight in export figures	York Aviation 2004
Investments	Investments in air transport activities in UK	OEF 1999, 2006
	Survey on the importance of transport connections with regard to other international cities; effects of a lack of transport connectivity on investments of UK companies; effect of the existence of air transport services on location decisions of companies	OEF 1999, 2006
	Share of companies, for which the existence of an airport was the main criterion for choosing the region around Munich airport as company location	York Aviation 2004
	Share of companies, which regard transport connectivity as essential factor within location planning processes	Healey and Baker, 2003
Networks/Connectivity	Survey about the importance of airports in UK for companies; importance of air transport services for location decisions of companies; acceptance of connectivity possibilities between flights; assessment of possibilities to fly non-stop instead of using transfer flights	OEF 1999, 2006
	additional value through the use of direct flights instead of indirect flights from Zurich airport (additional value per passenger and for the whole Swiss economy)	York Aviation 2004

Tourism	Number of international tourists and their expenditures	Office of National Statistics 2004
	Share of incoming tourists for Nizza and Wien including their duration of stay and their expenditures	York Aviation 2004
	Share of incoming tourists which use the plane for travelling purposes (differentiated by business, leisure, visiting friends)	"Economic Contribution of Civil Aviation", ICAO, 2004
	Air transport spin-off effects on employment and GDP in tourism	ATAG 2008

Table 11: Measurement framework of environmental impacts

Source: Wittmer et al. (2008).

Regarded Dimension	Description/Measurement of the Dimension	Source
Noise	Overall costs for EU17 differentiated by category (road, rail, air, water) in mill. Euro	INFRAS und IWW 2004
	Average costs differentiated by category (road, rail, air, water), Euro/1000 pkm resp. Euro/1000 tkm	INFRAS und IWW 2004
	Noise disturbance	European Environment Agency, 2004
	Number of people which are affected by more than 60 dB around three UK airports	Whitelegg 2000
	External noise costs at Frankfurt airport, mill. Euro per year, prices for 2000 (direct and indirect assessment): health impacts, direct assessment, indirect assessment, constrained settlement areas	Schmid et al., 2003 (for 2000 and 2015)
Air Pollution	Overall costs for EU17 differentiated by category (road, rail, air, water) in mill. Euro (TRENDS data for emissions and traffic volumes)	INFRAS und IWW 2004
	Average costs differentiated by category (road, rail, air, water), Euro/1000 pkm resp. Euro/1000 tkm	INFRAS und IWW 2004
	Zurich airport: NOx and HC emissions (in tonnes) for airport and region	Whitelegg 2000
	Share of air pollution at Frankfurt airport in overall air pollution in the region of Frankfurt	Whitelegg 2000
	Annual share of air pollution of Heathrow airport in the overall air pollution within the region of Heathrow (8x6 km)	Whitelegg 2000
	Air pollutant emissions of air transport at Frankfurt up to 600 metres over ground (t/a)	Schmid et al., 2003 (for 2000 and 2015)
	External overall costs for air pollutant emissions of Frankfurt airport (mill. Euro/a, prices of 2000)	Schmid et al., 2003 (for 2000 and 2015)
	CO2 emissions resulting from passenger air transport including all national flights plus the half of emissions resulting from international flights (in tonnes)	OEF 2006
	Costs for CO2 using the approach: GBP 70/tonne	"Aviation and Global Warming", Department for Transport, 2004
	Forecasts of the global development of green house gases	Whitelegg 2000

	Scenario depending share of aviations' global CO2 emissions	Whitelegg 2000
	Factors depending on air transport, which influence the atmosphere	Whitelegg 2000
	Environmental data for Zurich airport; development from 2000-2005: NOx, VOC and CO2 depending from air transport; NOx, VOC and CO2 in total	SSF
Climate Change	Climate costs in total (CO2, NOx, etc.) of the UK air transport industry	OEF 2006
	Overall costs for EU17 differentiated by category (road, rail, air, water) in mill. Euro (climate change high scenario 140 Euro/t CO2)	INFRAS und IWW 2004
	Average costs differentiated by category (road, rail, air, water), Euro/1000 pkm resp. Euro/1000 tkm	INFRAS und IWW 2004
	Climate effects and resulting external costs at Frankfurt airport (1 kg CH4 = 23 kg CO2, 1 kg N2O = 296 kg CO2), (EUR 2000 19/t CO2) for 1) air transport; 2) car transport and engines within the airport area; 3) upstream and downstream processes	Schmid et al., 2003 (for 2000 and 2015)
Urban Effects	Overall costs for EU17 differentiated by category (road, rail, air, water) in mill. Euro (EUROSTAT, Swiss study on costs of nature/landscape)	INFRAS und IWW 2004
	Average costs differentiated by category (road, rail, air, water), Euro/1000 pkm resp. Euro/1000 tkm	INFRAS und IWW 2004
Upstream and Downstream Processes	Overall costs for EU17 differentiated by category (road, rail, air, water) in mill. Euro (Ecoinventory for the transport sector, 140 Euro/t CO2)	INFRAS und IWW 2004
	Average costs differentiated by category (road, rail, air, water), Euro/1000 pkm resp. Euro/1000 tkm	INFRAS und IWW 2004
	External costs for upstream and downstream processes at Frankfurt airport (mill. Euro 2000/a)	Schmid et al., 2003 (for 2000 and 2015)
Accidents	Overall costs for EU17 differentiated by category (road, rail, air, water) in mill. Euro (IRTAD, UIC, EUROSTAT)	INFRAS und IWW 2004
	Average costs differentiated by category (road, rail, air, water), Euro/1000 pkm resp. Euro/1000 tkm	INFRAS und IWW 2004
Total external costs	Overall average external costs (road, rail, air, water), Euro/1000 pkm resp. Euro/1000 tkm	INFRAS und IWW 2004

9.2 Abbreviations

AACC	Airport Associations Coordinating Council (since 1991 known as ACI)
ACI	Airports Council International
AEA	Association of European Airlines
AMS	Amsterdam Schiphol Airport
ANCA	US Airport Noise and Capacity Act
ASNA	US Aviation Safety and Noise Abatement Act
ATAG	Air Transport Action Group
ATM	Air Traffic Management
ATRS	FAA's Automated Radar Terminal System
BBI	Berlin Brandenburg International
BRU	Brussels Zaventem Airport
BUR	Bob Hope Airport
CAEP	ICAO's Committee on Aviation Environmental Protection
CBA	Cost-Benefit Analysis
CDA	Continuous Descent Approach
CDG	Paris Charles de Gaulle Airport
CEA	Cost-Effectiveness Analysis
CEFA	Council for Environmentally Friendly Aviation
CPH	Copenhagen Kastrup Airport
db	decibel
DLR	Deutsches Zentrum für Luft- und Raumfahrt (German Aerospace Centre)
EC	European Commission
ECAD	European Center for Aviation Development
EEA	European Express Association
EMA	East Midlands Airport
EPNdB	Effective Perceived Noise in decibels
EU	European Union
FAA	US Federal Aviation Administration
FAR	US Federal Aviation Regulation
FRA	Frankfurt Airport
FSNC	Full Service Network Carrier
GDP	Gross Domestic Product
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization

IFR	Instrument Flight Rules
IHK	Industrie und Handelskammer (Chamber of Industry and Commerce)
LCC	Low Cost Carrier
LHR	London Heathrow Airport
MPD	Airport Advisory & Management company
MSAs	Metropolitan Statistical Areas
OECD	Organisation for Economic Co-operation and Development
O&D	Origin & Destination
Omega	Partnership for Aviation in a Sustainable World
RNAV	Area Navigation
SID	Standard Instrument Departure
SMEs	Small and Medium Enterprises
STAR	Standard Terminal Arrival Route
UAE	United Arab Emirates
UK	United Kingdom
US	United States of America
USSR	Union of Soviet Socialist Republics
VIE	Vienna Airport

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DLR at a glance

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