



Regional airports revisited: Unveiling pressing research gaps and proposing a uniform definition

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ABSTRACT

This paper aims to identify gaps in the literature and present a future research agenda for investigations on regional airports. The research topics appearing from the systematic literature review are linked to the roles that regional airports have held and currently hold. In this way, challenges and research gaps that deserve extra attention are identified. Moreover, the paper deals with one of the most pressing research gaps, the definition of a regional airport. The literature and accompanying industry review reveal a diverse use of the term regional airport, and ACI Europe (2017) and the European Parliament (2021) even indicate that there is currently no definition for a regional airport in Europe. To address future research and challenges of regional airports in a more unified and structured manner, a proposal is made to capture the term 'regional airport' based on objective criteria. With the dual outcome of possibilities for future research and a proposal for a common use of a definition of regional airports, we aim at a more coordinated and impactful progress in research concerning regional airports.

1. Introduction

Regional airports are integral components in the global aviation network, fulfilling functions such as feeding hub airports, facilitating low-cost carriers (LCCs) and providing essential air services in remote and rural regions. Historically rooted in a military, political and social role, regional airports have evolved toward more profit-focused entities. While the transformation towards profit-oriented operations signifies a shift in priorities, it also brings forth new challenges and potential research directions for regional airports.

One of these challenges is the complexity of the term 'regional airport' due to the absence of a universally agreed-upon definition. The existence of various types of regional airports across continents and regions causes different definitions for the term 'regional airport'. The definition is primarily constructed upon factors such as the volume of throughput, the role played by the regional airport, and its geographical location. More specifically, definitions of regional airports range from 'a regional airport is an airport with less than 3 million passengers', to 'a regional airport is an airport with less than 10 million passengers', and from 'a regional airport is an airport with flights to hub airports' to 'a regional airport is an airport accommodating flights to other regional airports' or 'a regional airports is an airport (primarily) serving large cities'. Consequently, the absence of a comprehensive, overarching definition that accommodates these distinct types results in inefficient communication among stakeholders, an inability to compare data,

a potential confusion in research findings and a hindering of an optimal deployment of (policy) interventions.

Therefore, the overall aim of this paper is, first, to dive deeper into what has already been investigated regarding regional airports and, in turn, draw up a future research agenda. Second, this paper navigates the intricate web of interpretations surrounding the term 'regional airport', revealing diverse perspectives and criteria. After that, there is proposed an overarching, uniform definition based on objective criteria to overcome confusion, enabling cohesive research and effective policy development in the realm of regional airports.

In the first phase of the paper, a systematic literature review was carried out to obtain a comprehensive overview of the research topics that have been previously investigated in the context of regional airports. This involved searching for records with the term 'Regional Airport*' in the title on various databases such as Scopus, Web of Science and Google Scholar. This yielded a total of 1277 records, which, after removing duplicates and filtering based on the title, the abstract and eventually the full text, came to 106 records for a full-text analysis.¹ Fig. 1 demonstrates the selection process in more detail.

¹ The screening resulted in removing records with a different main topic than regional airports such as a narrow focus on airlines (including low-cost carriers), networks, passenger quality service, safety, forecasting, noise impact methodologies or records without an abstract or full-text available (in English).

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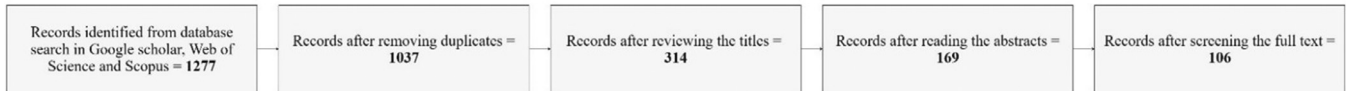


Fig. 1. Article selection process (own composition).

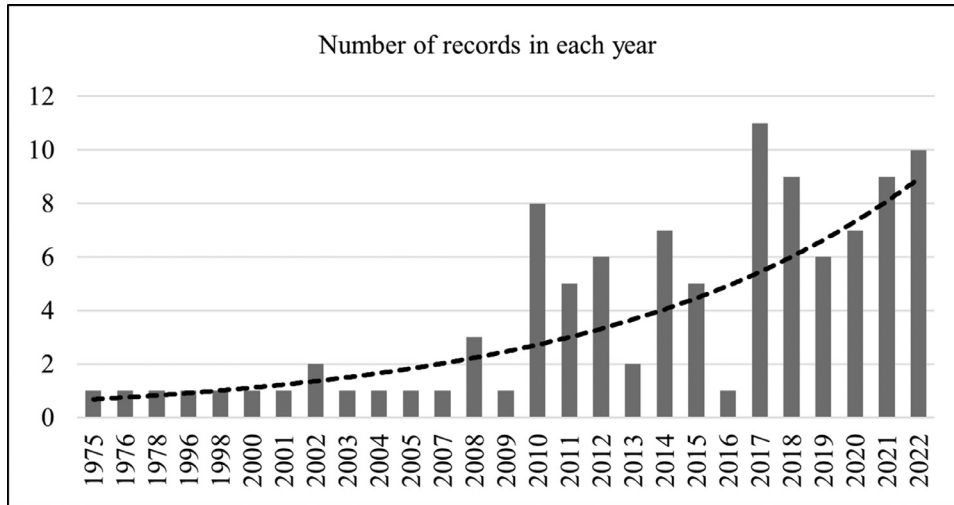


Fig. 2. Number of records in each year (own composition).

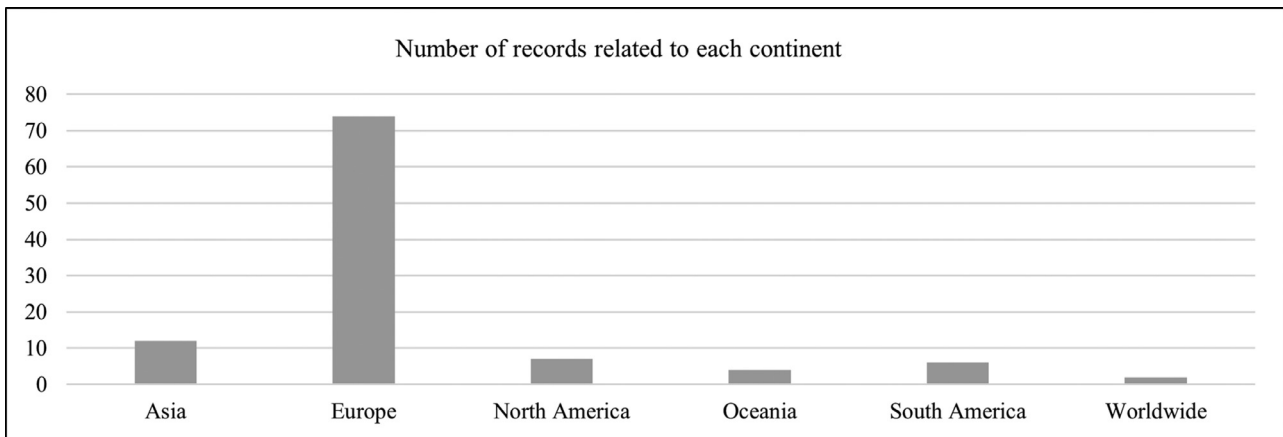


Fig. 3. Number of records related to each continent (own composition).

After the selection process, the 106 records were ordered according to the year of publication (Fig. 2) and the study's geographical scope (Fig. 3). Publishing records concerning regional airports has a clear upward trend, with the highest number of records in the last decade. Some potential reasons for this increase are: the rise of low-cost carriers that have reshaped the erstwhile role of regional airports and the shift of low-cost carriers from regional to major airports, about which more in the next section. It may also be a consequence of restrictions on state aid imposed by the European Commission (EC) on regional airports (guidelines ref. 2014/C 99/03), as well as the long series of EC investigations/decisions related to state aid cases offered to low-cost airlines by/at regional airports.

With regard to the geographical distribution of the examined records, emphasis was primarily placed on Europe. More detailed scrutiny of papers on case studies specific to European countries revealed a notable concentration in the United Kingdom (13%) and Central and Eastern Europe (e.g. Poland, Slovak Republic, Czech Republic; 37%). In Asia, 38% of the records feature case studies on India; in South America, Brazil (67%) is the predominant focus; North America's examined records exclusively include case studies from the United States, and

Oceania highlights regional airports in Australia. This highlights an initial literature gap, notably in case studies of European countries beyond those specified and case studies of regional airports outside Europe.

The content of the articles is discussed in the following section. This section incorporates the roles that regional airports have been performing over time and are currently performing, the accompanying research topics in that period and the gaps that could be identified from this analysis. Thereafter, Section 3 discusses one pressing research gap to be able to continue future research in the most structured and informative way and tackle upcoming challenges most effectively. More specifically, the third section includes the various definitions of regional airports and a proposal for change. In the final section, the conclusion is described and the future research agenda is transformed into 28 potential research questions.

2. The walks of life of regional airports with accompanying research

This section includes the different historical reasons for constructing regional airports in the first place, the (in many cases) changing

nature of the role from a military, social and political role toward an economic role fostered by the introduction of hub-and-spoke systems, the liberalization of air transport and the emergence of low-cost carriers. Moreover, it will become apparent through the following overview how the evolution of the roles of regional airports also changed the focus of research topics, emphasizing shifts from developmental concerns to efficiency analyses and, finally, to an exploration of economic and environmental impacts. This trajectory provides valuable insights regarding gap analysis and future research directions in this field.

2.1. Laying the foundation: a military, social and political role

There could be identified three main reasons for the construction of regional airports in the first place. Those reasons comprise a military, social and political role. The military role refers to the period in which regional airports were built as operating and training bases to enhance a country's defense capabilities; by, for instance, surveilling the airspace and providing emergency assistance and essential logistical support for military operations. The military airports were constructed at strategically important locations (McMullen, 1941). In more recent research by Sennaroglu and Celebi (2018) a multiple-criteria decision method is used to understand the location problem of military airports. They concluded that the military criteria (e.g. the level of military necessity in the region and the distance to military units) substantially predominated in the determination of a military airport location. In contrast, Ulman (1941) stated that the government selected places for military airports with an emphasis on the potential future civil use of the airport. In this regard, the Federal Aviation Administration administered a multi-billion dollar Airport Improvement Program. In the Military Airport component, military airports received funds to convert it to either a public-use commercial service or reliever airport. The conversion was intended to enhance airport and air traffic control system capacity in major metropolitan areas and reduce flight delays (Surgeoner, 1999).

Apart from the military reasons for construction, regional airports were built to perform a social role. This social role firstly, applies to remote and rural regional airports which are located in inaccessible and less densely populated regions and need regional airports to enable mobility and connectivity (Adler et al., 2013; Donehue & Baker, 2012; Kazda et al., 2017; Montoya-Quintero et al., 2022; Nömmik & Antov, 2017; Sennaroglu & Celebi, 2018). For instance, in regions such as Northern Scandinavia or the interior of Australia, access to air services is critical for health care, basic needs supplies, education, etc. (Adler et al., 2013; da Costa & Ribeiro, 2019; Graham, 1997; Merkert et al., 2012; Olariaga, 2021; Vaz et al., 2014). By providing adequate air connectivity, the isolated region is made more attractive to maintain the population of those regions in place (Olariaga, 2021; Tveter, 2017). Mathisen and Solvoll (2012) stated that the main argument for constructing regional airports in Norway was establishing efficient transport communications between rural towns and airports in the county centers. Because the sparse population density makes it difficult to justify the existence from an economic perspective, some regional airports with rather a social function need subsidies to continue air services (Baker et al., 2012; Bernier, 2010; Hájek & Grebeníček, 2010; Montoya-Quintero et al., 2022). Secondly, regional airports have a social role in providing general aviation services such as training flights and aerial work (Donehue & Baker, 2012). Finally, the social role has an emergency aspect in which it may be used as a backup airport (Cempírek & Dočkalíková, 2018) or for crisis management, such as firefighting (Große et al., 2021).

The political role entails that "owning airports is regarded as a high status for the region, and thus it is attractive for local governments and politicians to construct an airport in the region" (Yoshida & Fujimoto, 2004). As a result, some of those airports are not necessary from a demand point of view, which means that the capacity might exceed the demand in those regions.

In relation to the period of construction, research mainly consisted of reports and theses about the development potential of regional airports, the market feasibility of a new regional airport, their contribution and the context in which they operate (Chan, 1996; Drake & Williams, 1998; Smith, 1978; Winfrey et al., 1975).² The context was observed from a political point of view, including the different stakeholders in a decision-making framework and the business point of view in which privatization and the airport-airline relationship were considered (Feldhoff, 2002; Francis et al., 2004; Graham & Guyer, 2000; Humphreys & Francis, 2002). In general, research in this period was primarily represented by case studies, geographically covering regional airports in North America, Europe (United Kingdom) and Asia (Japan).

2.2. Towards comparative analysis: an economic role as feeder and low-cost facilitator

In the second stage, "regional airports could, at best, act as feeder points in network carriers' hub-and-spoke system or expect some seasonal charter traffic" (Papatheodorou & Arvanitis, 2009). In this way, regional airports strengthened (domestic) air connectivity and the territorial cohesion of countries (Olariaga, 2021). Moreover, this made regional airports start ensuring employment opportunities (Nömmik & Antov, 2017).

In relation to the more economic role regional airports began to play in the second stage, regional airports also started to experience more competition. This was the case because of the growth of the hub-and-spoke network model, enabling large and medium-sized airports to become the dominant airport hubs in their respective regions (Beifert, 2016; Bootsma, 1997; Reynolds-Feighan & McLay, 2006; Wu et al., 2011). Apart from this, High-Speed Train (HST) stations with overlapping catchment areas with regional airports started to be developed, lowering air transport demand and airline attractiveness (Grimme et al., 2018; Starkie, 2009). Sharing the catchment area with other (primary) airports, thus operating in a multi-airport system (MAS) (Graham, 2018; Postorino & Praticò, 2012)³, could bring opportunities when congested hub airports use the spare capacity of regional airports to transfer negative hub impacts such as noise (Graham, 2018; Remencová & Novák Sedláčková, 2021).

Interesting to cite is the economization of the role of regional airports that seems to be closely linked with an economization of research topics with a clear focus on using resources as efficiently as possible. In the decade between 2003 and 2013, research started to be oriented toward comparative analysis based on efficiency benchmarking and impact studies (Adler et al., 2013; Augustyniak, 2014; Augustyniak et al., 2015; Chutipongdech & Vongsaroj, 2022; Merkert et al., 2012; Remencová & Novák Sedláčková, 2021; Tapiador et al., 2008; Yoshida & Fujimoto, 2004). More specifically, within the benchmarking studies, geographical (Hájek & Grebeníček, 2010), technical (Barros et al., 2013; Hong & Jeon, 2019; Montoya-Quintero et al., 2022; Nicolas et al., 2012), structural (Thomas & Jha, 2022) and financial efficiency were investigated by applying a variety of methods, such as the Data Envelopment Analysis (DEA), bootstrap DEA, Total Factor Productivity (TFP), Stochastic Frontier Analysis (SFA), and Partial Productivity Measure (PPM). The methods were used to analyze different case studies, including Asia (India and Japan), North America, South America (Colombia), various countries in Europe (including the United Kingdom, Netherlands, Czech Republic, Germany, Italy, France, and Norway) and Oceania (Australia). In addition, impact studies based on economic factors (Mathisen & Solvoll, 2012) as well as environmental factors

² More recently, an evaluation methodology was created by Dimitriou and Sartzetaki (2022a) for the development of new regional airports.

³ A MAS is a multi-airport system where one primary airport serves more than 20% of the passenger traffic and the other airports all serve between 1% and 20% of the passenger traffic.

(Dimitriou & Voskaki, 2011) started to gain importance. Those impact studies were primarily based on modelling and cost-benefit analysis.

Apart from benchmarking, research also widened in other directions regarding the emergence of low-cost carriers (LCCs) and the accompanying 'new' role for regional airports (Papatheodorou & Arvanitis, 2009). The intensified use of regional airports was initiated by the liberalization of the European air transport market in 1997 (Graham, 1997; Marinakos & Poulaki, 2019; Papatheodorou & Arvanitis, 2009; Postorino, 2010a). Regional airports enjoyed an increase in traffic because of the rise of LCCs; bringing passengers from a much wider catchment area (Barrett, 2000; Lei & Papatheodorou, 2010). This created a fast development of regional airports (Cepolina & Profumo, 2010). Tapiador et al. (2008) and Hájek & Grebeníček (2010) also concluded that the traffic growth helped to revive and revamp regional airports to businesses which could bring economic opportunities to their hinterland. The impact of LCCs on the economic performance of regional airports was also investigated by Lei and Papatheodorou (2010), Červinka (2017) and Malavolti and Marty (2017).

More specifically, regional airports could benefit from increases in revenues and connectivity, enhancing the economic development of certain regions (Kazda et al., 2017; Sedláčková & Švecová, 2018b). For instance, some underdeveloped, decentralized regions became attractive tourism destinations because of the (re)development of the airport (Carballo-Cruz & Costa, 2014; Daries Ramón & Cristóbal Fransi, 2017; Hájek & Grebeníček, 2010; Marinakos & Poulaki, 2019; Papatheodorou & Arvanitis, 2009; Tapiador et al., 2008). The success factors for developing and maintaining low-cost regional airports in India were investigated through a fuzzy-based MCDM model by Pandey et al. (2018). In addition, offering services from regional airports could contribute to an increased local travel experience and reduced travel time (Molla, 2020). The advantages for LCCs to opt for regional airports comprised a primitive initial infrastructure of regional airports, which opened doors for customized new developments, slot availability and low marginal costs (Barbot, 2006; Hájek & Grebeníček, 2010; Tapiador et al., 2008).

Červinka (2017) addressed the disadvantages of LCCs revamping regional airports, such as increased competition because military air bases started entering the market of regional airports. Furthermore, this increased competition between regional airports created market power for LCCs and reduced the bargaining power of regional airports. This allowed LCCs to decrease the charges they must pay at regional airports. This pressure on the charges of regional airports also brought research topics such as (the costs and benefits of) airport subsidies Forsyth and Campus (2007) and the financial stimulation of regional airports (Hein, 2011) to the surface.

2.3. Expanding horizons: challenges of regional airports

In the last decade, research has become more oriented toward regional airports' broader effects and challenges. This includes an economic, societal and environmental aspect, explained in the paragraphs below.

First, several academia and representatives of umbrella organizations such as ACI refer to an economic (viability) problem of regional airports (Adler et al., 2013; Beifert, 2015; Červinka, 2019; European Parliament Auditors, 2014; Graham, 2018; Khanka et al., 2018; Nömmik & Antov, 2020; Remencová & Sedláčková, 2021; Sedláčková & Švecová, 2018a; Starkie, 2009; Thomas & Jha, 2024). A study by the European Court of Auditors (2014) demonstrated, for instance, that 48 percent of Europe's airports are loss-making and that "it is, in particular, the case for smaller, regional airports which the public authorities may wish to maintain for socioeconomic reasons". Fig. 4 illustrates the percentage of European, small regional airports making losses in 2019 (ACI, 2019). As substantiated in the European Court of Auditors document (2014), the financial situation gets worse for smaller regional airports. More specifically, the figure demonstrates that 71% of regional airports serving less than 1 million passengers yearly make losses, which drops to

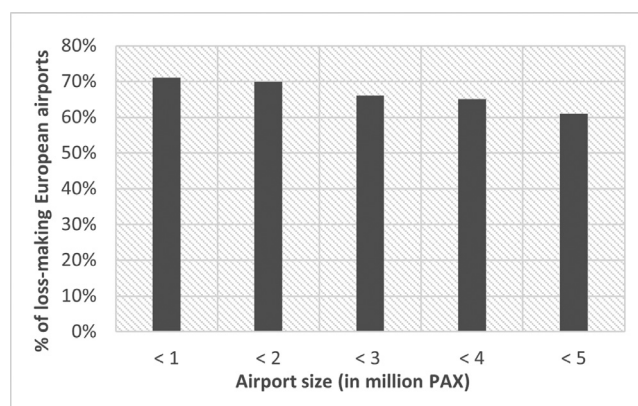


Fig. 4. Percentage of loss-making European airports in 2019 (own composition based on ACI Europe, 2019).

61% for regional airports serving less than 5 million passengers yearly (ACI, 2019; Červinka, 2019). Due to this economic viability challenge, several studies have raised questions regarding the economic justification of regional airports. Moreover, regional airports face relatively high costs, which can be described as unavoidable infrastructural sunk capital and operational costs (Budd & Ison, 2020; Donehue & Baker, 2012). The challenge for regional airports is that the infrastructural requirements do not vary much depending on the airport size (Kazda et al., 2017). This means that regional airports, which receive less operational revenue due to a lower throughput than national hub airports, have to cover infrastructural costs with substantially less revenue and often face the inability to exploit economies of scale optimally. In addition, the adjustment of LCCs business models has increased the economic pressure on the role. More specifically, Dobruszkes et al. (2017) demonstrated that LCCs are increasingly flying from major airports, causing regional airports to lose market share.

This economic challenge is also closely associated with primary research topics such as profitability, investments and economic/regional development that were investigated in regard to regional airports in the last decade. The profitability of regional airports was examined by looking at influential factors for the generation of aeronautical revenues (Wan et al., 2015), actions to increase the profitability of a specific case (Daries Ramón & Cristóbal Fransi, 2017), the relationship of annual passenger traffic with operating revenue and operating expenses (Iyer & Jain, 2020) and a Public-Private Partnership (PPP) as a more financially viable alternative for the management of regional airports in Brazil (da Costa & Ribeiro, 2019). Moreover, the competition of regional airports was investigated by comparing the competitiveness level of regional airports in Finland (Pashkevich et al., 2017) and by looking at the competitive advantages of primary, secondary and regional airports within Turkey (Lapcin, 2021).

In addition, investments, subsidies and state aid were highly researched by several academics. More specifically, Babagolzadeh et al. (2022) looked at how subsidies could help shift air freight from metropolitan airports to regional airports and Kalinowski (2014) examined the impact of investments in regional airports on efficiency while Górecka and Baran (2018) looked at the efficiency of investments. More recently, Vaz et al. (2014) approached it from the other side by investigating the attractiveness of receiving investments in regional airports. Kazda et al. (2017) questioned whether the sum needed to sustain regional airport operations could be justified from the taxpayer's perspective.

Investments and subsidies often aim to increase economic/regional development, connectivity, tourism and spillover effects. An increasing research trend has been observed on this societal subject. For instance, Vaz et al. (2014) investigated how investments could be attracted to foster economic development in terms of tourism for a case in

Portugal. Considering the impact; [Tveter \(2017\)](#) demonstrated a positive but not significant effect of Norwegian airports on population and employment via a difference-in-difference design, [Breidenbach \(2020\)](#) concluded that in the dense network of German airports, the surplus of connectivity due to one additional regional airport in a specific region is small and [Dimitriou and Sartzetaki \(2022a and 2022b\)](#) addressed the diversity of economic impact on business ecosystems based on an input-output analysis. Moreover, [Pot and Koster \(2022\)](#) assessed the link between air accessibility - focusing on smaller airports - and regional economic development across European regions. Finally, several case studies have been investigated focusing on the importance of regional airports for economic development. More specifically, [Cempírek and Dočkalíková \(2018\)](#) investigated regional airports in the Czech Republic, [Olariaga \(2021\)](#) in Colombia, [Molla \(2020\)](#) in Finland, [Große and Olausson \(2020\)](#) in Sweden and [Marinakos and Poulaki \(2019\)](#) and [Nataliya \(2017\)](#) in the Leningrad region.

Finally, there is also a growing emphasis on research related to innovation in both the industry and literature. For instance, environment-related topics gain importance. More specifically, [Thieffry \(2014\)](#) dealt with state aid for the use of renewable energies at regional airports, [Boiral et al. \(2019\)](#) looked into sustainability issues at remote and rural regional airports, [Datey et al. \(2023\)](#) questioned if noise pollution would be significantly reduced when existing aircraft would be replaced with electric aircraft, and [Meindl et al. \(2023\)](#) described various potential solutions for airport infrastructure (e.g. ground power supply options) at regional airports. In addition, subjects such as regional airport modernization ([Ližbetinová et al., 2018](#)), the introduction of digital technologies after COVID-19 ([Remencová et al., 2022](#)) and crisis management ([Große et al., 2021](#)) entered the literature.

2.4. The walks of life of regional airports: discussion and gap analysis

To provide a future outlook, [Fig. 5](#) is included. This figure, firstly, summarizes the shift or completion of regional airports' military, social, and political roles to/with the economic role as a feeder and facilitator of LCCs. This evolution seems to be closely linked with three different kinds of developments regarding ownership: airport commercialization, where the public utility changes to a commercial enterprise; airport privatization, where the management and ownership transfers to the private sector; and airport ownership diversification, where different types of investors are included ([Graham, 2018](#)). A consequence of those new structures is that the operation is driven more commercially with a business-like management philosophy ([Bowyer et al., 2020; Fasone et al., 2014; Graham, 2018; Ison et al., 2011; Minato & Morimoto, 2011; Novák Sedláčková & Remencová, 2022; Remencová & Novák Sedláčková, 2021; Sedláčková & Švecová, 2018b](#)). Therefore, it can be concluded that regional airports moved from rather human-focused airports to rather profit-focused airports.⁴ Moreover, the challenges that are emerging in more recent research could foster a second evolution of the role of regional airports. More specifically, the challenges include an economic aspect due to the inability to optimally exploit economies of scale and LCCs widening their focus to major airports; a societal aspect in which the role of regional airports in providing surplus connectivity is questioned and an environmental aspect which fosters (research that considers) new innovations.

From the research overview that provided insights into this evolution of roles and the recent challenges, different directions for future research can be distilled. These research directions are outlined below and include, on the one hand, the gaps we could discover in the literature and, on the other hand, the research directions arising from the challenges and the current role regional airports hold.

The first topic that deserves extra attention is the remote and rural regional airports, which mainly serve a social role. As described earlier, academics such as [Baker et al. \(2012\)](#), [Donehue and Baker \(2012\)](#), [Bernier \(2010\)](#) and [Boiral et al. \(2019\)](#) laid the foundation of research about this type of regional airports. However, these studies were mainly of a qualitative and descriptive nature. As a result, quantitative research questions regarding the added value of remote and rural regional airports remain understudied to date. Moreover, general management practices and regulatory frameworks to optimize the often subsidy-driven types of regional airports are interesting to consider.

The evolution towards a more economic role fostered research on competition (with HST or between regional airports functioning in a MAS), LCCs and efficiency. Nevertheless, it would be interesting to go one step further and analyze the impact of competition and the trend of LCCs starting to fly more to larger airports, which [Dobruszkes et al. \(2017\)](#) demonstrated. This impact on regional airports could be observed from a profitability or total welfare point of view by applying a computable general equilibrium (CGE) model. In relation to benchmarking studies, many different methods have already been tested in various case studies. However, the question still arises to undertake a larger-scale benchmarking research in terms of time and space. In this way, trends within efficiency can be examined and any differences between regions can be identified. In addition, a combination of quantitative and qualitative research could give empirical support to the results obtained, for example, by using a survey. Finally, addressing challenges specific to (regional) airport benchmarking research would be beneficial. For instance, current research does not take into account the heterogeneity of regional airports and has not yet addressed or investigated the impact of the fixed cost structure on (the results of) benchmarking studies.

When regional airports' economic challenges started to gain importance in the literature, they were mainly explored from a case study perspective. Therefore, a comparative study with profitability variations between regional airports and the reasons could be an added value to the current literature. Furthermore, it might be beneficial to investigate potential improvements to the economic situation such as the impact of (air freight) fares and non-aeronautical revenues on the profitability of regional airports. [Thomas and Jha \(2022\)](#) also cited the relationship between efficiency and profitability of (regional) airports as an interesting avenue for further research. Finally, the impact of subsidies on the national welfare level has also not been investigated before.

This economic challenge creates a link to the current pressure on the societal role and the connectivity aspect. For instance, research has already revealed that the surplus of connectivity due to one additional regional airport in a specific region in Germany is small. However, broader research on the optimal number of regional airports based on connectivity and the differences between regions is not currently available.

Finally, it is important to consider innovative aspects and the potential future business models of regional airports. Considering environmental innovations, the impact of drones and sustainable aviation fuel on regional airports should be considered alongside noise and electric aircraft. Regarding the process of innovation and implementation, it might be interesting to look at the potential impact of collaboration between stakeholders and (regional) airports within the same region. Finally, exploring effective business models for regional airports could serve as a valuable area for further research, according to [Remencová et al. \(2022\)](#). This can be initiated by comparing the effectiveness (according to KPIs) of business models of regional airports through cluster analysis. In addition, air cargo as part of a regional airport business model is also cited as interesting to consider by [Beifert \(2015\)](#), [Budd et al. \(2015\)](#) and [Budd and Ison \(2020\)](#). For instance, [Beifert \(2016\)](#) stated that "an efficient deployment of appropriate strategies, with an integration in the air cargo supply chain, may bring many advantages not only to the main stakeholders like airports and airlines themselves but also to the regional community in terms of economic and social benefits, as well as improved accessibility".

⁴ Although a certain shift was observed, this does not mean that the rather human-focused airports are no longer present in the current landscape of regional airports.

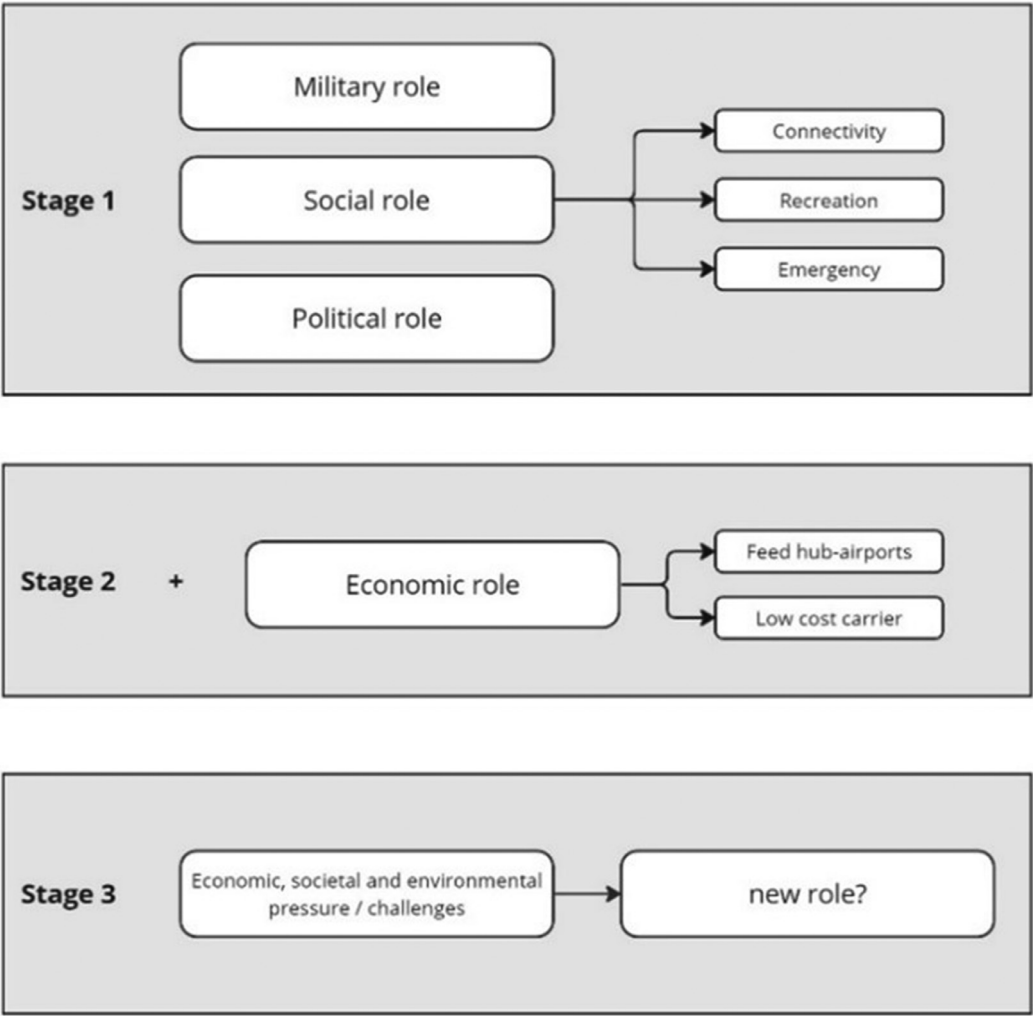


Fig. 5. Roles of regional airports over time (own composition).

However, before these research gaps can be approached in the most structured and informative manner and the challenges addressed most effectively, it is essential to talk, write policy and act on the same type of airport. After all, what ultimately is a regional airport, what types of regional airports exist and which criteria are used to define this term?

3. Towards a common definition for regional airports

Several academics already cited the confusion surrounding the term ‘regional airport’ (de Castro Ribeiro et al., 2011; Fageda et al., 2019; Graham & Guyer, 2000; Iyer & Jain, 2020) and ACI (2019) and the European Parliament (2021) even indicate that there is currently no definition for a regional airport in Europe. In addition, Chang (2010) highlighted the challenge of defining regional airports in Asia due to the continent’s extensive airport coverage. In this context, Starling et al. (1976) noted that the term ‘regional airport’ can be conceptualized through various approaches such as the size, the location, the area served or the users’ perceptions of the airport. In contrast, the term ‘regional’ cannot be seamlessly substituted with ‘small’, ‘local’ or ‘domestic’ airport as this encompasses another definition and typically corresponds to a different category of airports (Dobruszkes et al., 2017; Iyer & Thomas, 2021; Pot & Koster, 2022).

In what follows, the different ways in which a ‘regional airport’ is described in earlier studies are listed and discussed. The definitions

could be categorized into four groups: the first group concentrates on the number of passengers, the second group considers the role and activities that regional airports are performing, the third group focuses on the location of the airport and the last group deals with the exceptions.

3.1. Defining regional airports according to the number of passengers

The first group entails the regional airports defined according to the number of passengers they serve annually. The European Commission often uses the number of passengers when considering aid regulations. In most cases, a regional airport is considered an airport with average annual passenger traffic up to three million passengers (Červinka, 2019; Červinka & Matušková, 2018; Olariaga, 2021; Sedláčková & Švecová, 2018a; Thomas & Jha, 2022) whereas some research institutions put the limit higher, at for instance five million passengers (Vogel, 2020). In some cases, the European Commission makes use of another definition which prefers a distinction between large regional airports with one to five million passengers per year and small regional airports with less than one million passengers per year (European Parliament Auditors, 2014; Olariaga, 2021; Postorino, 2010a; Postorino & Praticò, 2012). Chang’s (2010) study, focusing on Asia, employed the Air Transport Intelligence Database, utilizing criteria such as international passengers of less than one million and domestic passengers exceeding 80 million

to characterize regional airports. In India, airports with less than 10 million passengers per annum have been defined as regional airports by [Iyer and Jain \(2020\)](#) and in Brazil, regional airports are airports having an annual movement of fewer than 800,000 passengers in the Legal Amazon Region and 600,000 passengers for the other regions, according to Law No. 13097/2015 ([Vaz et al., 2014](#)).

Although there is different usage in the number of passengers applied as a threshold, there is agreement in the literature that passenger numbers are an objective parameter to divide airports into categories and thus filter regional airports. We do not only see different thresholds at a continent level, but also within the European continent, different thresholds are used. This points to a disagreement that could lead to confusing conclusions about research and policy regulations on regional airports. In addition to potential confusion, this set of definitions specifically excludes cargo airports by concentrating solely on passenger numbers. According to the definition, there is no subdivision of cargo airports and all cargo airports are, by definition, not regional airports.

ICAO makes use of a classification according to the traffic density by the number of movements per runway during rush hour instead of the number of passengers. This could be a way to approach both passenger-focused and cargo-focused regional airports ([Olariaga, 2021](#); [Postorino, 2010b](#)).

3.2. Defining regional airports according to their role and activities

The second group describes regional airports according to their role and activities. In some definitions, regional airports are airports that feed into hub airports ([Beifert, 2016](#); [Olariaga, 2021](#); [Vogel, 2020](#)); in others, they are defined as non-hub airports ([European Parliament Auditors, 2014](#); [Nömmik & Antov, 2020](#); [Olariaga, 2021](#); [Remencová et al., 2022](#)).

Moreover, regional airports are described as airports that serve a region ([Chan, 1996](#); [Starling et al., 1976](#)) or airports that provide infrastructure for regional airlines ([Yoshida & Fujimoto, 2004](#)). When considering the destinations, regional airports are defined as airports that provide a network of short-haul scheduled international services, a significant range of charter services and domestic services, including links with gateway airports ([Edmunds, 2011](#)). [ACI \(2019\)](#) is less specific and describes it as airports that primarily serve short and medium-range routes and primarily serve point-to-point destinations ([Červinka & Matušková, 2018](#); [Olariaga, 2021](#); [Vogel, 2020](#)). Furthermore, [Beifert \(2016\)](#) states that regional airports are “airports that offer direct flights to other regional airports, herewith fulfilling the connection function to the centers of socio-economic activity” and [Dobruszkes et al. \(2017\)](#) focus on airports not serving (or at least not primarily serving) large cities.

Regarding the role and activities, the literature is fairly unanimous, but the way of defining those roles and activities can still lead to confusion. Generally, it can be concluded from the above definitions that a regional airport is not considered a hub airport but rather an airport serving as a feeder for a hub airport or an airport providing direct, point-to-point regional flights. While seemingly clear, listing regional airports falling under this category proves challenging due to the lack of concrete and objective criteria. Which regions do we mean when a regional airport is defined as an airport serving a region, and what, for example, is a regional flight or airline? [ACI \(2019\)](#) defines flights from regional airports as short- to medium-haul point-to-point flights, but exactly which flights fall into the short- to medium-haul category? Answering these questions is essential to obtain a conclusive, reliable, general definition of a regional airport.

In this regard, ICAO classified airports according to the type of routes offered and their associated distances ([Olariaga, 2021](#)). By classifying the airports more concretely with a differentiation according to the domestic, international or intercontinental nature of the destination and the number of kilometers, the filtering of regional airports on a global level could be done more effectively.

3.3. Defining regional airports according to their location

The third group concentrates on the location of airports to define which airports are regional ones. For Japanese airports, regional airports are the ones located outside metropolitan regions, according to [Feldhoff's \(2002\)](#) definition. In other definitions, regional airports are located away from the major cities ([Breidenbach, 2020](#); [Denis, 2008](#)) or have a principal catchment area that is not a capital city ([European Parliament Auditors, 2014](#); [Olariaga, 2021](#); [Remencová et al., 2022](#)) or they are part of a medium or small city that is mainly served by short-haul regional services ([Červinka & Matušková, 2018](#)). In the study of [Thomas and Jha \(2022\)](#), regional airports may be located in places with challenging geography and topography or do not need to be far from city centers ([Iyer & Thomas, 2021](#); [Nömmik & Antov, 2020](#); [Thomas & Jha, 2022](#)).

Hence, the literature generally agrees that regional airports are situated away from capital cities, although the specific dimensions of the cities remain unspecified. This categorization criterion for airports is seldom taken as the sole point of comparison. This means that the categorization of airports based on location is often taken together with the airport's role or the number of passengers the airport serves on a yearly average. In addition, this category is often perceived as inconclusive; for example, the definition by [Thomas and Jha \(2022\)](#) states that ‘they may be located in places with challenging geography and topography or do not need to be far from city centers’.

3.4. Defining regional airports in other terms

In some studies or in some countries, regional airports are described in exceptional ways. For instance, [Price et al. \(2008\)](#) define airports based on the density level estimated by the number of jobs they provide.

Moreover, in the studies of [Denis \(2008\)](#) and [Lian and Rønnevik \(2011\)](#), regional airports are described according to the aircraft type. For instance, [Denis \(2008\)](#) depicts that regional airports facilitate flights with turboprop aircraft and small jets of up to about 100 seats capacity. The definition of [Lian and Rønnevik \(2011\)](#) is more narrow by considering regional airports offering flights with turboprop aircraft and main airports offering flights with jets.

[Larsen and Lassen \(2017\)](#) focus on ownership and state that “regional airports are owned by the regional municipalities, and that the policies and strategies related to the airport's development are formed in a regional context”.

In the United Kingdom, regional airports are considered airports outside London with scheduled passenger services ([Baker et al., 2012](#)). In a study by [Graham and Guyer \(2000\)](#), regional airports are even regarded as all airports lacking international stature, like London Heathrow and Gatwick.

Finally, in the United States, the Federal Aviation Administration (FAA) categorizes airports in two steps. In the first step, commercial traffic (depending on the annual number of passengers boarded) is used to differentiate between a primary and non-primary airport ([Federal Aviation Administration, n.d.](#); [Olariaga, 2021](#)). Within the category of non-primary airports, which are “Commercial Service Airports that have at least 2,500 and no more than 10,000 passenger boardings each year”, regional airports are defined as airports that “support regional economies by connecting communities to regional and national markets. They are generally located in metropolitan areas and serve relatively large populations. Regional airports have high levels of activity with some jets and multiengine propeller aircraft. The metropolitan areas where regional airports are located can be Metropolitan Statistical Areas with an urban core population of at least 50,000 or Micropolitan Statistical Areas with a core urban population between 10,000 and 50,000” ([Federal Aviation Administration, n.d.](#)). The definition of the FAA includes different parts of the definitions described above; however, it also contrasts in some ways. More concretely, the first differentiating step uses the number of boarding passengers, yet the threshold significantly differs from those

observed on other continents. Furthermore, the regional airports defined by the FAA are located in metropolitan areas, whereas regional airports defined by most other academia are located outside metropolitan areas.

3.5. Defining regional airports: discussion

The above literature and industry review pointed out the heterogeneity in (the definition of) regional airports. To foster knowledge and research about regional airports, it would be pertinent to use the same umbrella definition in which all kinds of regional airports are captured on a world level or at least on a continent level. In relation to this, it is of utmost importance not to use different terms such as small airports, local airports, domestic airports, general aviation airports, secondary airports, remote and rural airports interchangeably with the term 'regional airport'. Some of the terms might be part of the term 'regional airport', such as small, remote and rural airports, which in most cases fall under the category of regional airports; however, secondary or domestic airports will in some cases not fall under the category of regional airports as it is described now. Recognizing the complexity of the issue, it would be ideal to apply the most concrete and objective criteria to define a regional airport.

- The number of passengers is commonly used and objective; however, the specific boundaries differ. In this regard, ACI Europe stated that "the catchment area and/or annual traffic of an airport are not valid indicators of whether an airport is regional or not" (Olariaga, 2021). In addition, cargo airports are excluded when only considering the number of passengers. Hence, considering workload units (WLU) as the primary criterion could be of interest. Although there is criticism regarding the use of WLUs in the sense that the aggregation method remains arbitrary, it still seems to be the most appropriate method to date. The use of movements could make regional airports that focus on general aviation and training flights (with touch-and-go's) appear more sizeable compared to other regional airports.
- The role and activities are also widely applied to determine a regional airport; however, the definitions are often not concrete enough and are described with different words. Therefore, it would be optimal to further define, for instance, a short- to medium-haul flight and to standardize the use of these criteria in research.
- The location of the regional airport is, in most cases, employed as an add-on criterion to the earlier-mentioned criteria and is not often conclusive on its own. In future research, the location of a regional airport might be of interest to further categorize regional airports. For example, the rural and remote regional airports might be allocated to another group of regional airports than regional airports located in or near a metropolitan area.

Considering the aforementioned discussion points, crafting a comprehensive definition for regional airports necessitates incorporating various aspects. The definition should not only allow for a nuanced categorization of airports but also be flexible enough to resonate with diverse continents, ensuring that the delineation encompasses the unique characteristics and contexts of each region. For instance, the number of WLUs could be considered a first objective criterion; however, it should be broad enough to include regional airports in, for example, India, which are located in places with a higher population density. Therefore, the highest threshold based on the number of WLUs should be around 10 million to align with the high threshold in the definition for Indian regional airports of Iyer and Jain (2020). Moreover, there could be opted for a differentiation factor that considers the function as a non-hub airport and the nature of the destinations. This can be enabled by including criteria such as 'mainly (i.e. 80%) point-to-point and short-to-medium haul flights for civil purposes'. Short-to-medium haul flights can be described as flights up to 5,000 km (Albers et al., 2020; Boeing, n.d.; European Union Aviation Safety Agency, EASA; KLM Royal Dutch Airlines, n.d.; Pejovic et al., 2008; Williams & Noland, 2006). Finally, the location of the regional airport could be applied to further categorize

regional airports in, for instance, regional airports close to metropolitan areas or regional airports in remote or rural areas. This results in the following definition: 'a regional airport is an airport that serves less than 10 million WLUs on mainly (> 80%) point-to-point destinations and short-to-medium haul flights (i.e. flights up to 5,000 km) for civil purposes. It might be located in remote and rural areas or near a metropolitan area.'

The establishment of this comprehensive definition for regional airports presents several advantages for stakeholders involved in the aviation sector such as policymakers, airport authorities, and aviation researchers. For instance, this overarching definition that accommodates the distinct types could result in more efficient communication among the stakeholders, the ability to compare data globally, more cohesion in research findings and a more optimal deployment of (policy) interventions.

In light of future research directions, it might be of interest to conduct qualitative sessions according to an interview using the Delphi method or a focus group interview in which representatives of umbrella organizations such as the EU, ACI and ICAO as well as academics covering the different continents, discuss the potential use of the definition in future research (conclusions) and policy regulations.

4. Conclusions and future research directions

This paper provides a systematic literature review on regional airports by considering the evolution of the role of regional airports and accompanying research in that specific period. Moreover, the different definitions for a regional airport that are used in both the literature and industry are discussed. This indicates a remarkable heterogeneity in (the definition of) regional airports. However, to help aviation stakeholders tackle future challenges most effectively and continue research in the most structured and informative way, it would be pertinent to use the same umbrella definition in which all kinds of regional airports are captured. This common definition should be based on objective criteria such as the number of WLUs as the highest threshold to capture passenger- and cargo-focused airports. Furthermore, this should be complemented with route definitions such as point-to-point destinations and short-to-medium haul flights defined in the number of hours or kilometers and might be complemented with diversification criteria based on the location of the regional airport. When aggregated, the following definition emerges: 'a regional airport is an airport that serves less than 10 million WLUs on mainly (> 80%) point-to-point destinations and short-to-medium haul flights (i.e. flights up to 5,000 km) for civil purposes. It might be located in remote and rural areas or near a metropolitan area.' However, before this definition can be applied in future research, the potential should be evaluated by expert interviews, and umbrella organizations should confirm the definition to enable a streamlined use of the definition. Therefore, the first and probably most urgent research question is: 1) 'Does the proposed umbrella definition of regional airports apply to the different types of regional airports and encompass the most objective criteria?'

4.1. The changing nature of roles

Apart from the definition, there has been elaborated on the role that regional airports have been fulfilling over time. In this investigation, we first analyzed the main historical reasons for constructing regional airports, namely the military, social and political reasons. The social role of remote and rural regional airports as a connectivity provider was researched by Baker et al. (2012), Donehue and Baker (2012), Bernier (2010), Boiral et al. (2019), Große et al. (2021) and Olariaga (2021). Because their research mainly focused on qualitative case studies, it raised new research questions such as: 2) 'How do remote and rural regional airports influence the GDP of a region?', 3) 'Which management practices prove successful in optimizing the performance of remote and rural regional airports, with a focus on addressing unique challenges associated with their size and

Table 1
Potential future research questions (own composition).

Themes and subthemes	Research questions
Definition of Regional Airports	
Acceptance of Definition	1) Does the proposed umbrella definition of regional airports apply to the different types and encompass the most objective criteria?
Changing Nature of Roles	
Remote and Rural Regional Airports	2) How do remote and rural regional airports influence the GDP of a region? 3) Which management practices prove successful in optimizing the performance of remote and rural regional airports? 4) How do government policies impact the social contribution and management of remote and rural regional airports?
LCCs	5) What is the influence of increased operation of LCCs at major airports on the financial situation of regional airports? 6) What is the influence of increased competition on the financial situation of regional airports? 7) How are LCCs flying from regional airports influencing the welfare of a region, and how can these effects be analyzed?
Efficiency Analysis and Comparisons	8) How can a comparative efficiency analysis take into account the heterogeneity in regional airports? 9) How does the fixed cost structure of airports affect efficiency analyses? 10) What are the trends in the efficiency of regional airports over a long-term time series? 11) Which factors influence efficiency changes among regional airports and does this differ by region? 12) How can the comparison of regional airports inform best practices and policy recommendations for different regions? 13) Which empirical insights can be gained through the combination of benchmarking and survey methodologies?
Challenges of Regional Airports	
Economy	14) What factors contribute to the profitability of regional airports, and how does profitability vary across airports? 15) How is profitability related to the overall efficiency of airport operations? 16) How do non-aeronautical revenues contribute to the financial sustainability of regional airports? 17) How do (air freight) tariffs at regional airports impact their financial performance? 18) Which methodologies are most effective for conducting a comprehensive economic impact assessment of regional airports?
Society	19) What are the welfare effects of regional airport subsidies on the region, nation, and broader communities? 20) Which methodological approaches can be employed to comprehensively assess the economic significance of regional airports? 21) How does the significance of regional airports vary across social, economic, environmental, and innovation perspectives? 22) What is the relationship between the number of regional airports and overall connectivity?
Environment and Innovation	23) What are the potential implications for regional connectivity if there are changes in the number of regional airports? 24) How do UAM projects and drones impact the role of regional airports? 25) To what extent are environmental developments influencing the operations and sustainability of regional airports?
Business models	26) Which methods can be used to estimate and compare the environmental performance of regional airports effectively? 27) What are the effective business models of regional airports based on a cluster analysis? 28) In the context of regional airports, how do collaborative efforts with stakeholders contribute to sustainability and efficiency?

location?’ and 4) ‘How do government policies impact the social contribution and management of remote and rural regional airports, and which improvements can be recommended?’.

Moreover, the development from a rather human-focused regional airport fulfilling a military, political and social role to a more profit-focused regional airport was observed⁵. This development was encouraged by the emergence of hub-and-spoke systems, the liberalization of air transport and the emergence of LCCs with the accompanying impact on regional airports. The impact of LCCs on regional airports later came under pressure by the evolving business model with increased operations from major airports. Although *Lei and Papatheodorou (2010)* and *Červinka (2017)* laid the foundation of research that looks into the impact of LCCs on the economic performance of the airport, it might be of interest to go one step further and analyze the total economic impact and welfare effects of LCCs and the increased operations from major airports via a CGE model. This also makes the bridge towards research that considers increased competition and its impact on regional airports. This would then correspond to the research questions: 5) ‘What is the influence of increased operation of LCCs at major airports on the financial situation of regional airports?’, 6) ‘What is the influence of increased competition on the financial situation of regional airports?’ and 7) ‘How are LCCs flying from regional airports influencing the welfare of a region, and how can these effects be effectively analyzed through a CGE model?’.

Together with the economization of the role of regional airports, efficiency analysis and comparisons have been gaining importance in the literature. Although much research has already been conducted on benchmarking methods and efficiency measurement, there remains a de-

mand for additional studies focusing on international comparisons and the analysis of long-term time series. Moreover, extended DEA analysis, such as the Malmquist DEA to decompose technical results and the bootstrapping or second-stage regression to improve objectivity and provide further hypothesis testing, as mentioned in the research of *Hong and Jeon (2019)*, could fill the gap in benchmarking research about regional airports. In addition, the results of a benchmarking analysis could be complemented with surveys to obtain more empirical results and challenges for efficiency benchmarking, such as the heterogeneity of regional airports and the fixed cost environment, could also be interesting to look at. When this is translated into research questions, we receive the following: 8) ‘How can a comparative efficiency analysis take into account the heterogeneity in regional airports?’, 9) ‘How does the fixed cost structure of (regional) airports affect efficiency analyses and is there a way to cope with this more effectively?’, 10) ‘What are the trends in the efficiency of regional airports over a long-term time series, and how do these trends contribute to our understanding of their performance and productivity dynamics?’, 11) ‘Which factors influence efficiency changes among regional airports and does this differ by region?’, 12) ‘How can the comparison of regional airports inform best practices and policy recommendations for different regions?’ and 13) ‘Which empirical insights can be gained through the combination of benchmarking and survey methodologies?’.

4.2. The challenges of regional airports

In addition to the different roles of regional airports, the current challenges of regional airports were investigated in relation to future research directions. These encompass an economic, societal, environmental and innovative aspect.

First, the economic challenge of regional airports was discussed. More specifically, it concerned investigations in the economic and

⁵ Although a certain shift was observed, this does not mean that the rather human-focused airports are no longer present in the current landscape of regional airports.

financial sphere, such as the profitability, investments, subsidies and methodologies to estimate the economic impact of regional airports. When the gaps in the literature are translated into research questions, they consist of: 14) 'What factors contribute to the profitability of regional airports, and how does profitability vary across different airports?', 15) 'How is profitability related to the overall efficiency of airport operations?', 16) 'How do non-aeronautical revenues contribute to the financial sustainability of regional airports, and what strategies can be employed to enhance and diversify these revenue streams?', 17) 'How do (air freight) tariffs at regional airports impact their financial performance, and what are the key determinants influencing tariff structures in different regions?', 18) 'Which methodologies are most effective for conducting a comprehensive economic impact assessment of regional airports?', 19) 'What are the welfare effects of regional airport subsidies on the region, nation, and broader communities?'.

Second, the societal pressure on the role of regional airports was analyzed. For instance, in recent research, Boiral et al. (2019) and Chutipongdech and Vongsaroj (2022) questioned the significance of regional airports for the community's economic development. In relation to this, Breidenbach (2020) investigated the surplus connectivity of regional airports in Germany. There could be build further on this research by, for instance, looking at the impact on connectivity if the number of regional airports in a country or region changes. This brings us to the following set of research questions: 20) 'Which methodological approaches can be employed to comprehensively assess and define the economic significance of regional airports within a given geographical context?', 21) 'How does the significance of regional airports vary across, for instance, a social, economic, environmental, and innovation perspective, and how are these dimensions counterbalancing each other?', 22) 'What is the relationship between the number of regional airports in a country or region and the overall connectivity?' and 23) 'What are the potential implications for regional connectivity if there are changes in the number of regional airports in a country or region?'.

Third, we could conclude that the environmental pressure in terms of pollution and noise gained importance in the literature and industry. This leads to research opportunities that consider innovations and environmental performance assessments. More concretely, the influence of Urban Air Mobility (UAM) projects and drones on regional airports' role is still understudied. In addition, the influence of environmental developments in terms of Sustainable Aviation Fuel (SAF), electric and hybrid flying on the business models of regional airports deserves more attention in the literature. Finally, methods to estimate and compare the environmental performance of regional airports would be an interesting direction for further research. In terms of research questions, this could mean: 24) 'How do UAM projects and drones impact the role of regional airports?', 25) 'To what extent are environmental developments, such as the adaption of SAF and the introduction of electric and hybrid flying, influencing the operations and sustainability of regional airports?', 26) 'Which methods can be used to estimate and compare the environmental performance of regional airports effectively?'.

The above innovations and adapted roles of regional airports could lead to renewed business models. This can be translated in the last set of research questions: 27) 'What are the effective business models of regional airports based on a cluster analysis?', and 28) 'In the context of regional airports, how do collaborative efforts with stakeholders contribute to both environmental sustainability and operational efficiency, and what best practices can be identified through comparative analysis across countries?' An overview of the proposed research questions is demonstrated in Table 1.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Jolien Pauwels: Conceptualization, Writing – original draft, Writing – review & editing, Funding acquisition, Investigation. **Sven Buyle:** Supervision, Validation, Writing – review & editing. **Wouter Dewulf:** Supervision, Validation, Writing – review & editing.

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