

INNOVATION AT AIRPORTS: A SYSTEMATIC LITERATURE REVIEW (2000–2019)

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Abstract. Airports operate in a highly-competitive and challenging environment. Therefore, in order to remain competitive, innovation is imperative for airports. This paper aims to conduct academic research into innovation at airports by reviewing studies published from 2000 to 2019 for presenting key findings. A systematic literature review was made based on scientific papers indexed in Scopus with the keywords innovation and airport in the title, abstract or keywords sections, consolidating the innovation focus, approach and degree discussed with respect to innovation areas and territorial focal points. Consequently, it was found that research on airport innovation is: (i) mainly focused on products/services, (ii) concerned with leveraging ICT (Information Communication Technology), (iii) implemented ad-hoc without a consolidated strategic approach, and (iv) lacks the input of external innovation scholars and specialists.

Keywords: airport, innovation, literature review, ICT, airport design, performance measurement.

Introduction

The air transportation industry is continuously changing (Chambers, 2007) with a rapid growth in both traffic and passenger expectations. Then, consumer trends, security developments and political changes have made air transportation even more challenging (Graham, 2009), where airports have a significant role. They are one of the enablers of this industry and have essential impact on regional wealth, employment opportunities and economic development (Graham, 2013). So, the success and continuous growth of airports are vitally important. Consequently, they need to upgrade themselves to introduce new products, services, processes, strategies and business models to remain competitive, which can be achieved by innovation (Humphrey & Schmitz, 2002).

Innovation is the added value generation (Jacobides et al., 2006) by new ideas, methods, or devices (Merriam-Webster, 2017). It is about the interaction of technology, market and organization, where competitive advantage can be achieved by generation and delivery of new product and service offerings (Tidd & Bessant, 2013). Today, companies invest a considerable amount of resources into it (Stock & Zacharias, 2011).

Many innovation efforts focus on new offerings (Jacobides et al., 2006), but there is a new focal shift in innovation practices from products and services towards co-

created value, i.e. the experience (Pralhad & Ramaswamy, 2003). Then, the value is also delivered by subject innovation in business processes (Organisation for Economic Cooperation and Development [OECD], 2005) or business model innovation (Amit & Zott, 2012). OECD (2018) defines beside product and process innovation also organizational, and marketing innovation. Consequently, airports have to internalize and practice all types of innovation, delivering new offerings, processes and high quality passenger experience, which particularly utilizes also new processes or technologies.

Despite the increasing focus of industry and academia on innovation in general, there is no research specifically focusing on the question how innovation can be achieved at airports. This study provides an extensive overview of academic research into innovation at airports to further quantify innovation examples with respect to areas of interest and types of innovation. So, the main purpose of the study is to examine studies conducted on airport innovation and to divide them into different categories accordingly how they address innovation, thereby determining the direction of innovation studies and practices. This study contributes to the existing literature by extending airport-innovation research framework for classification and identifying areas for future research. Besides, it makes contributions to practitioners by providing a practical guide in airport innovations.

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1. Background of literature

Innovation is mostly triggered by the need of creating new products or services with new technologies (Garcia & Calantone, 2002). Unlike inventions, innovations offer an economic value, i.e. innovations are implemented projects rather than bright ideas. Innovation can be differentiated in terms of its degree; there are incremental, radical or disruptive innovations. Incremental innovations represent a low degree of new knowledge, which are mainly reflected in small improvements, compared to radical innovations that involve a high degree of the latest knowledge towards a totally new solution (Dewar & Dutton, 1986) or a new value proposition (Christensen, 2013). Disruptive innovations have such a high impact that older propositions become outdated. Consequently, innovation is not necessarily around a bold idea and can be achieved in various levels.

The air transportation industry uses innovation not only to achieve cost effective strategies (Janić, 1999). The development is driven by innovation utilizing advanced business models, customer segmentation and new technologies (Franke, 2007). The competition among airports is a common driver of innovation (Huang & Kaewmee, 2011) that airports made innovation part of their business strategies recently (Ucler & Martin-Domingo, 2015).

Airports can benefit from innovation initiatives in the design, construction, operation and in passengers' experience processes. For example, one common area of innovation at airports is the use of information and communication technologies (ICT) for interaction that aim to offer efficient, fast and high quality services to customers (Straker & Wrigley, 2018). Some ICT examples are self-service technologies at check-in kiosks (Chang & Yang, 2008), automated board control technologies (Oostveen et al., 2014), radio-frequency identification (RFID)-based baggage tracking systems (Zhang et al., 2008), and mobile applications (Martin-Domingo & Martín, 2016). There, self-service technologies (SST) allow customers to interact with self-service software (Chen et al., 2015) without any employee involvement (Castillo-Manzano & López-Valpuesta, 2013). By using these technologies, customers can book a flight, pay for tickets and get flight updates via mobile devices (Lin & Hsieh, 2011) and companies can reduce labor cost, and increase both service efficiency (Lin & Hsieh, 2007) and time-efficiency (Chang & Yang, 2008).

Advanced technologies also enable people to do multiple tasks on their mobile devices while travelling (Harrison et al., 2013). More efficient mobile devices (Radaha & Johnson, 2013) have resulted in a higher usage of mobile applications and websites at airports. Such applications are simply the easiest and fastest way to provide information to air travelers, and they enable transactions and collaboration. For example, DORA is an application for door to door information of airlines, airports and landside interlines enhancing passenger experience (Baumgartner et al., 2016). Airport applications are often used to generate ancillary revenue from different activities, as for example lounges, car parking and food & beverage (Halpern &

Graham, 2013). In addition to new revenue sources, these mobile applications contribute to make airport processes more customer-friendly (Price et al., 2014).

There are many benefits of innovation at airports. For example, Niine et al. (2017) categorizes related outcomes into four main groups as the effect on service price, service quality, service volume and the potential to differentiate; Straker and Wrigley (2018) state that technology usage at airports increases passenger satisfaction; and Lin (2015) confirms innovations can deliver a unique airport's brand experience, which contributes its competitive advantage (Arif et al., 2013). As a result, airports clearly need to practice innovation, however there is no existing work in the literature consolidating airport innovation research as it is spread in various papers and there is no structured overview of innovation possibilities that airports can built their strategy on. Consequently, this paper aims to fulfill the research gap by summarizing and categorizing the airport innovation with usable findings for both the research community and the airport industry.

2. Methodology

This paper applies systematic literature review, which investigates existing studies on a certain topic to evaluate and analyze these studies, combining contributions and reaching results about what is and is not known (Denyer & Tranfield, 2009). The literature review on airport innovation is made by using journal articles, books and conference papers from the Elsevier's Scopus database, because it includes but it is not limited to major aviation-focused journals like *Journal of Air Transportation Management* and *Airport Management (SCImago)*; and major transportation journals like *Transportation Research-Part D, Transport and Environment* and *Journal of Transportation Engineering*.

It is worth to mention that qualitative research in such systematic reviews has been noted as methodological innovation itself (Dixon-Woods, 2010). The basic steps of the qualitative study here were accessing raw data, structuring and categorizing it to further analyze, conclude and interpret as stated by Schilling (2006). First, purposeful sampling (Palinkas et al., 2015) was used for in-depth study due to the rich seam of information (Patton, 2002). Publications were collected using the search criteria "innovation" and "airport" in the title, abstract or keywords sections, i.e. only manuscripts including both words "airport" and "innovation" in any of the indicated sections were selected. Only publications in English between 2000 and 2019 were included in the review. The technologies of the new millennium have facilitated many innovations and Bogicevic et al. (2017) recons that airports only began recently to invest on in technological innovations. In addition, only 55 documents were published during the 31 years' period between 1968–1999. Therefore, it can be concluded that the 20 years considered can be appropriate for future projections and technology road mapping attempts.

Purposeful sampling was carried out in three stages, after the used keywords delivered a total of 423 documents: First, 28 conference reviews and 8 short surveys were excluded, because of not being a complete academic resource. In the second step, Nvivo 10 was used due to its ability to import bibliographic references (Azeem et al., 2012). Although there are different computer-assisted software programs for conducting qualitative data analysis (Patton, 2002), Nvivo 10 was used because it has a user-friendly interface for organizing, categorizing and analyzing data (Castleberry, 2014) and delivers an effective coding environment with nodes, making it compatible with thematic analysis approaches (Zamawe, 2015). Since the program is not perfect limitations on data interpretation as described by Dollah et al. (2017) have been taken into consideration, and the control remained with the authors along all processes. The software was used to identify the word frequency of “airport” in the text. Consequently, 15 documents were eliminated with a frequency lower than 0.01%, where airports were mainly used just as an example of public places (Pica et al., 2015). Since the sample size is small and only short texts, i.e. abstracts, were scanned, validity and reliability tests were done manually. Then, in the third step, title, abstract and keywords of remaining documents were read by the authors and those in which innovations directly affect the management of the airports and its operations were selected that 179 documents were excluded focusing on air traffic management, new types of innovative aircrafts, unmanned aerial vehicles, aviation fuel consumption and countries’ economy. So that, 193 documents were considered for further analysis in this study.

In order to analyze relevant data in groups, an Excel Spreadsheet was used. First, a descriptive analysis of the data was performed with airport innovation papers classifying by journal name, year of publication and place of origin. Then, content analysis was conducted to distinguish types of innovations at airports. The topics covered in the papers were subsequently organized with the affinity diagram technique (Hanington & Martin, 2012), where papers were grouped based on their similarity of application. This was made by using cards with short descriptions, tentatively used by a group of experts to form idea clusters. This group of experts were either working in the industry or in academia specifically focusing on innova-

tion and aviation, who did select the most general titles for categories and assigned the literature under these categories. As a result, a total of four innovation areas were identified and tabulated: Airport Design, Performance Measurement, ICT and General. In addition to this, approach and degree of the innovation were identified for each paper. While the approach of innovation was adapted from OECD (2018), it was evident during the research that there were no marketing and organization innovation examples. Consequently, the outcomes were easier to be clustered under (i) object innovation that defines innovative changes in products and services, and (ii) subject innovation that defines improvement in processes, which was also particularly in line with the older Oslo Manual definitions. The degree definitions for innovation were adapted from studies of Ettl et al. (1984) and Augsdörfer et al. (2013).

3. Findings

3.1. Descriptive analysis

First of all, the geographical spread of the innovation studies was looked at to quantify differences between geographic regions. This coverage is given in Figure 1, which is based on the total of 193 papers subject to this study. Papers without a specific location were designated as worldwide (43%). Then, it was determined that the majority of the specific studies were addressing airport innovation in Europe (27%). This was assumed to be a result of the European Union’s (EU) transformation policy towards an innovation nation, driven by grants in the Horizon 2020 Framework Programme for Research and Innovation (H2020) with calls regarding societal challenges, smart, green and integrated transportation, and further supported by academic projects such as Clean Sky, DORA, SESARJU. These initiatives in the EU could partially explain the greater amount of academic research on airport innovation than in other parts of the world.

Then, the annual change of the innovation research was investigated by a frequency chart to quantify the expected increase over the years as mentioned by Fagerberg and Verspagen (2009). On the one hand, it was observed that most papers were published in recent years that it is safe to say that there is an increasing interest in innovation

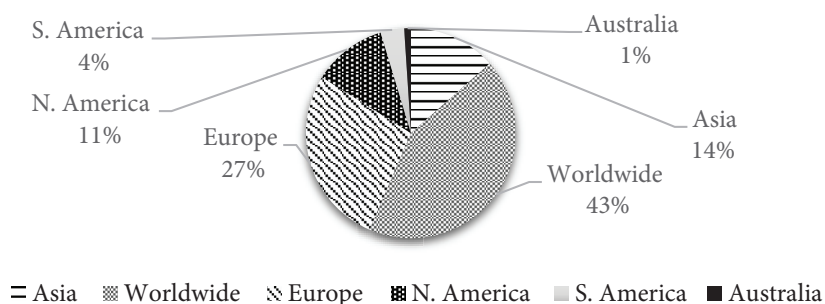


Figure 1. Geographical coverage of airport innovation literature

at airports. On the other hand, the research was not continuous: in 2010 there were no publications on airport innovation and the average of 2009–2012 has by far a lower mean frequency than 2008 and 2013. One can say that the method of this study narrowing down to the papers with the search words “airport” and “innovation” in specific section of papers might be the reason. However, this ontology context is also existing in other years that it is an interesting fact, which could be explained with related calls of support programs. Under the bottom line, the predominance of relevant papers appeared within the last seven years as shown in Figure 2.

Moreover, there were 157 different journals, where the 193 selected papers appeared in accordance with the search criteria. During the search, there was neither a preferred field such as aviation, nor a restriction based on the field of the journals. However, Journal of Airport Management, Journal of Air Transport Management and Jane’s Airport Review were the most common sources with the highest number of published papers, 7, 5 and 4 respectively. So, the majority of the research was done by aviation scholars in aviation related journals. Furthermore, the number of studies of each author on this subject was counted manually and there was a smooth distribution of papers across authors, i.e. authors have written 1 or maximum 2 papers about airport innovation, which indicates that there is a gap in the literature for scholars concentrating solely on airport innovation research.

3.2. Content analysis

Content analysis is a systematic way (Mayring, 2004) to study repeating patterns in various formats such as text, video or other communication means. It is widely used in qualitative research allowing researchers categorizing words into less content-related categories (Elo & Kyngäs, 2008). Here it was also used categorization. Consequently, the papers were divided into 4 groups in terms of the topic they cover, namely General (53%), Airport Design (19%), ICT (15%) and Performance Measurement (13%). The distribution of these 4 areas in airport innovation was then examined within 193 papers with respect to frequency and coverage which are explained next.

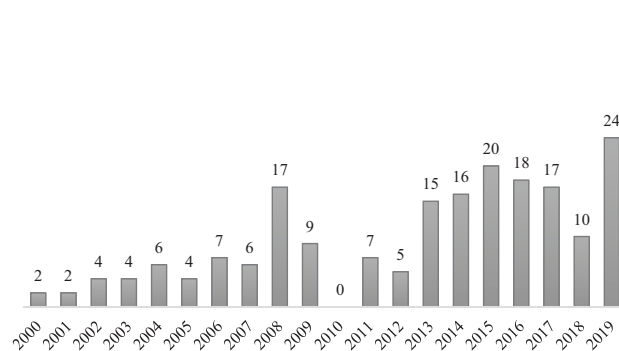


Figure 2. Publication years of the studies on airport innovation literature

3.2.1. The general objectives on airport innovation

102 papers did mention airport innovation generally without any specific focus, or the focus area was singular that there was no possibility to assign a category for that. Thus, there are papers in the general objectives category, which examined airport innovation from many different perspectives. Such innovations can be found in different parts of the airport and examples of different were classified in this category with respect to the associated approach and degree for innovation (see Figure 3).

The most frequently mentioned innovation related general topic was security. Some specific technologies were also in security related papers, but innovations were only facilitating but not focusing on ICT. Consequently, such security papers were included in the general objectives section and there was no separate category created for security. As an example, Thomas et al. (2016) states about facial recognition software used at airports as well as Jupe and Keatley (2019) mention how artificial intelligence can be used for coping with security issues at airports, and Möller et al. (2018) talk about intelligent system application with the Internet of Things. Then, some studies like Wong et al. (2006) and Boussadia (2009) addressed the historical development of security technologies used at the airport, where privatization was one of the major driving forces (Bowyer & Chapman, 2014; Sinha & Jha, 2019). Risk analysis was another aspect of security mentioned by Kyriazanos et al. (2016) and Filipoui et al. (2012).

Likewise, there was a significant focus on the passenger experience (Pat-El & Orshan, 2015; Elliott & Radford, 2015; Melnikova et al., 2018; Hinterholzer & Garsia-Alonso, 2018; Mayer, 2019). Then, numerous studies have examined the effects of airport on administrative issues such as R&D projects (Brooker, 2009), process management (Gubenko & Ksenofontova, 2015) and pricing strategies (Basso & Zhang, 2006). Marketing concerns such as service and brand loyalty (de Oliveira & Caetano, 2019), passenger loyalty (Akamavi et al., 2015), customer satisfaction (Arif et al., 2013; Lin, 2015) were investigated.

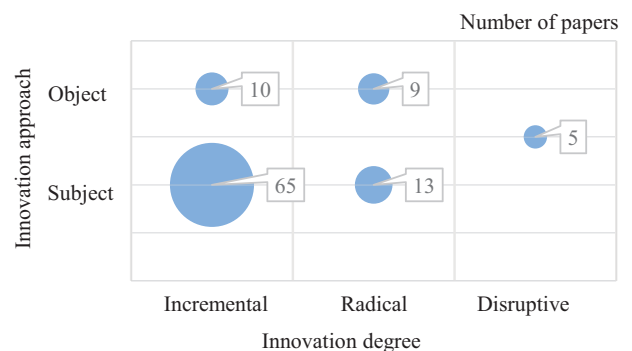


Figure 3. The associated approach and degree for innovation of general objectives category

3.2.2. Design

Airport design itself is a difficult and complex process, which includes several stages such as planning and constructing (De Neufville & Odoni, 2003). The importance of innovations on airport design was found to be considerable as innovative facilities provide smooth service processes both for service providers and passengers with a great impact on efficiency (Medvedev et al., 2017). Consequently, the most frequently mentioned field of innovation after the general case was design studies with a total of 36 of papers (see Figure 4). Although there was small attention to subject innovation in this category, the object innovation was discussed in depth for the land- and the airside. In terms of airside, innovation was found to be implemented on runways (Herrema, 2014), taxiways (Crawford, 2008; Schmidt et al., 2012), navigation systems (Mayer et al., 2015) and airfield pavements (Hachiya et al., 2005; Dawson et al., 2008; Lazar & Emery, 2013). For the landside, innovation was part of the construction (Harty, 2005; Guangshe et al., 2008) and terminal facilities (Davies et al., 2009; Gil et al., 2012). So, innovations for developing aeronautical as well non-aeronautical revenues were included.

3.2.3. Information Communication Technologies (ICT)

ICT directly affects customers service perceptions (Brida et al., 2016). It can be used at airports for self-service machines or security equipment (Chen et al., 2015), impacting on the experience and thus customer satisfaction (Chen & Wu, 2014; Yu & Huang, 2014; Chen et al., 2015). Consequently, it has been subject of academic studies that there were 30 publications within this category corresponding to 15% (see Figure 5). Furthermore, many other papers such as security do also leverage ICT as stated above that the coverage is even larger.

When all of these studies are examined, it is possible to observe a trend over years: While the focus in early 2000s was on “people mover systems” (Sproule, 2001, 2009), the focus shift latter towards mobile applications (Kohno & Fujii, 2011; Fei et al., 2016), RFID systems (Khan, 2011;

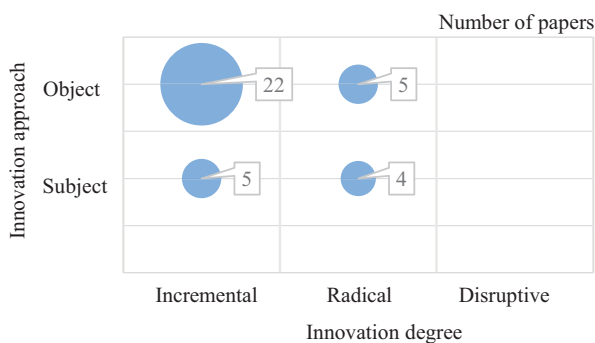


Figure 4. The associated approach and degree for innovation of design category

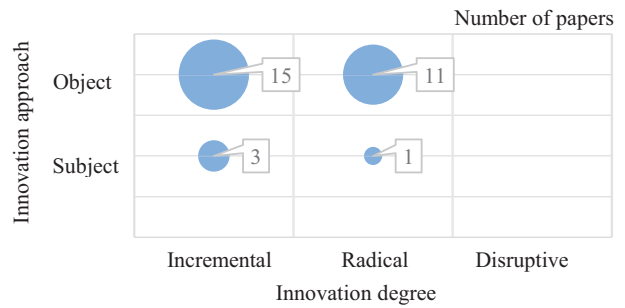


Figure 5. The associated approach and degree for innovation of ICT category

Mirza & Brohi, 2013), SST's (Kim et al., 2017; Bruno et al., 2019) and biometric systems (Kim et al., 2019; Negri et al., 2019). People mover systems are still being used at airports (Kapala, 2009), but they became industry standard over time that they are not classified as an innovation anymore. Therefore, it is possible to say that people mover system is one of the oldest technology used at airports (Sproule, 2009). Nevertheless, new ICT technologies are more recent, and in particular self-service technologies, which are becoming the “new standard” at airports allowing passengers different choices based on their preference (Ueda & Kurahashi, 2016). These technologies are used at different passenger processes like check-in (Bruno et al., 2019); biometric control systems, facial recognition systems and automated border control systems (Oostveen et al., 2014; Duman, 2019; Kim et al., 2019; Negri et al., 2019); and baggage handling (Kim et al., 2017). The acceptance of such technologies were one of the main concerns of the research papers in this category and their impact on passenger's experience was researched (Chen et al., 2015; Fei et al., 2016).

3.2.4. Performance measurement

From the operations research perspective, the performance and profitability are key. Thus, efficiency is an important key indicator, which is used as a guide in strategic planning and competitive analysis of airports (Bazargan & Vasigh, 2003). Performance measurement is not an easy task because airports are large complex business environments consisting of different processes distributed across distinct companies, which is further complicated by regulatory issues (Graham, 2013). However, this challenge is also the driving force for innovation (Pitt & Tucker, 2008). Consequently, innovation in performance measurement was found to be a critical research area concerning airport economics and management (Fasone & Zapata-Aguirre, 2016) and 25 publications were classified under the category for airport performance (see Figure 6).

When airport performance is looked at in depth, there are two main vertices, which are managerial and operational performance. In line with this distinction, research was evident in effective wayfinding in terminal building (Ardi et al., 2019), digital technologies that are used in airport ground operations (Kovynyov & Mikut, 2019), taxi

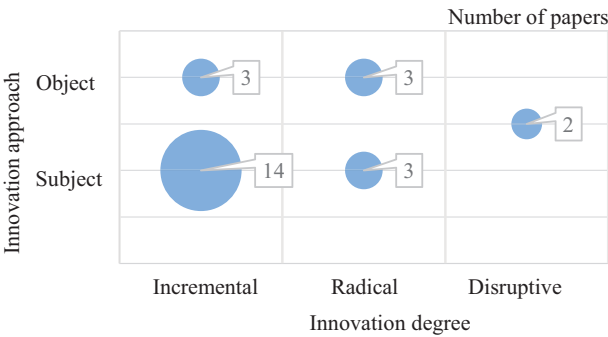


Figure 6. The associated approach and degree for innovation of performance measurement category

systems affecting ground operation and gate congestion (Soepnel & Roling, 2017), and evaluation of performance of asphalt types (White, 2017). Then, in managerial perspective of the airport performance, studies gave attention to capacity management (Aulman, 2018), efficiency concerns (Neto et al., 2019) and business performance (Fasone & Zapata-Aguirre, 2016).

4. Discussion

As Cooper (2011) states, a good mix of different innovation typologies is required in organizations to maximize success. This varies from simple improvements towards bold innovations with a disruption potential. This can be achieved either by new products and services, or by new processes. Organizational innovation can be challenging for airports due to a tight regulation. Then, despite airports having a tremendous marketing innovation potential it was not evident in the literature. Therefore, further categorization for the innovation approach was based on subject and object innovation (Taran et al., 2015), which is also in line with the former OECD (2005) definitions. Subject innovation was mentioned recently more than object innovation, where it was more common in papers classified in general objectives (Figure 7). This shift from object to subject innovation might support the new focal point of experience (Chao & Kavadias, 2008) and co-creation, but it can also simply be due to the lack of research

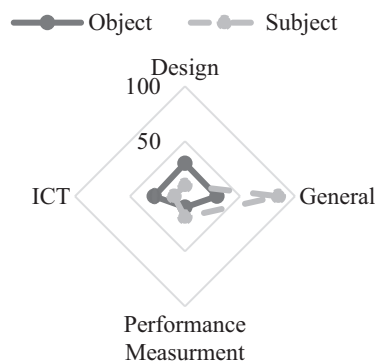


Figure 7. Innovation approach by category

related to object innovation at airports. Whatever the reason might be, there is a gap which can be best filled with game-changing bold innovation. Consequently, strategic planning for airports must involve bold innovation targets filling up all the “strategic buckets” (Chao & Kavadias, 2008) including subject as well object innovation for different strategies.

Furthermore, the degree of innovation was categorized according to OECD (2005) as (i) incremental innovation when there is a continuous improvement in product and services (Bhaskaran, 2006), (ii) radical innovation when there is crucial change in input to output processes (Hage, 1980) and (iii) disruptive innovation, described as a game changer, which brings new value proposition to products and services (Christensen, 2013). Consequently, Figure 8 shows the summary of the analyzed research subject to the degree of innovation. Incremental innovation was the most common subcategory under study with 134 papers (70%). It was also found that incremental innovation had the largest coverage with 80 papers in general objectives. Consequently, the majority of the work is focusing on enhancements of daily routines. Then, there were 49 papers (25%) for radical innovation. Finally, there were only 7 studies addressing disruptive innovation at airports, where design and ICT were not covered at all. Moreover, there were studies not investigating solely disruptive innovation, but looking at it in conjunction with the other categories, which covered 5% of papers. This was no surprise, because disruptive innovations require a vast amount of changes and all of these changes occur with different dimensions over time, which progress at airports is expected to be very slow due to the legislations and the nature of the processes.

Lastly, the revenue sources of airports were analyzed and classified as (i) aeronautical revenue, (ii) commercial revenue and (iii) indirect value. Considering that aeronautical revenues are revenues generated from airlines’ operation activities (Battal & Bakir, 2017), they include landing fees, passenger service charges, aircraft parking and hangar fees, and ground service charges. Consequently, non-aeronautical revenues or commercial revenues are explained as revenues generated from activities

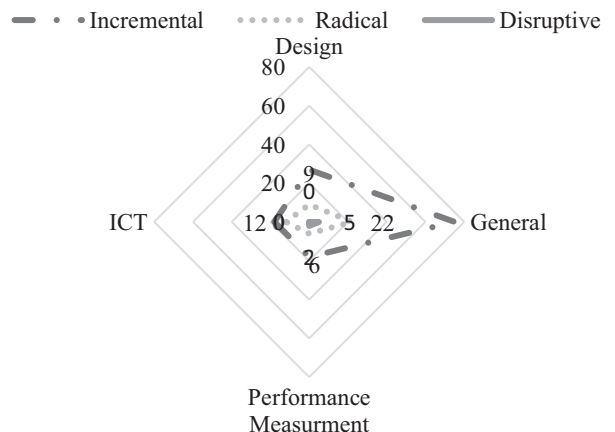


Figure 8. Innovation degree by category

not directly related to airline operation activities (Doganis, 1992). The third subcategory, the indirect value of innovation, represents gains which cannot be reckoned with traditional accounting (Grant et al., 2013), which impact cannot be detected easily, especially in the short term. Indirect value for airports includes impacts over time either due to system enhancements reflected in air traveler satisfaction, or it is built in the ecosystem/supply chain. Consequently, this subcategory also includes impacts on the related local economy.

There, the performance measurement and design focused more on the revenue side of the business, but the research on airport innovation was found to be more concentrated on indirect values. Indeed, ICT and general categories addressed indirect value in long term. Consequently, there is an ambiguity in value creation with respect to the definition of innovation. Innovation is about quantifiable value and ought to include measurable outputs via products or services. However, the literature tends to lack such connections and instead the indirect value is a major focal point. Nevertheless, indirect value is mostly within subject innovation and, which can only be useful when considered together with new products or services, i.e. the object side is less focused on at airports. This might also be a result of grants in the H2020 program, trackable to the societal challenges and transformation efforts of the EU, but the end effect remains the same. Consequently, scholars and airport professionals have to focus more on new products and services along marketing innovation, which has not been researched.

Specific examples suggest that the focal area of airport innovation can be further quantified. For incremental innovation, there is a focus on ICT value (Smith & Ugolini, 2017), infrastructure enhancement (Lorenzo et al., 2004), and usage of electrical vehicles (Silvester et al., 2013). In addition, there are different optimization projects such as optimization of terminal to reduce environmental impact (Lister, 2008), runway optimization (Herrema, 2014) and reengineering in cargo handling processes by business process modelling and automation technologies (Gubenko & Ksenofontova, 2015). This is underlining the traditional nature of airports, i.e. consolidated large organizations focusing on the enhancements rather than the change itself.

Furthermore, there are enhancements in design, training, border control, self-service technologies such as check-in and baggage handling, radio frequency identification (RFID), security (Gil et al., 2012; Chen et al., 2015; Negri et al., 2019), and sustainability telepresence systems in order to reduce time for drop-off/ pick-up and improve transportation (Ryley et al., 2013), which can be categorized as both incremental and partially radical innovations. Aside from these, the interconnection of the duty free chain in distinct locations (Ucler & Martin-Domingo, 2015), and smart airport design (Elliott & Radford, 2015) are examples of radical innovation utilizing ICT improvements. As stated before, these studies did not deal with disruptive innovation solely.

Prior to the research, technological push aspects such as technology transfer from robotics, Industry 4.0 and augmented reality (AR) were expected to be significantly present in the airport innovation research. Similarly, new modes of transportation like hyper loop, or new aircraft types such as spacecraft, new very large aircraft or small vertical take-off and landing (VTOL) aircraft were not covered in the innovation literature for airports. Thus technology push did not play a major role there. Instead, marketing pull with respect to innovation at airports was the major concern of researchers and airport professionals funding the research. This might also be interpreted as indicating that airport professionals work in a reactive manner, excluding strategical innovation efforts in their usual agenda or that they prefer to address such information internally. This can also perhaps be interpreted as a consequence of the limited competition environment in the airport sector. Whatever the reason might be, there is room for improvement especially by technology road mapping and technology scouting.

Then, there was no direct evidence of new product or new service innovations at airports, i.e. the literature did not include new offerings at airports. Even if it would seem that there should be such papers, since they are not interrelated with airports specifically, they were not found with the present keywords. A further interesting point is that technology-focused papers are not reporting on innovation, i.e. are not concerned with the conversion to commercial products or services, or don't address value in the processes. This underlines the lack of collaborative product/ service development among researchers and airport professionals. Thus, airport management could adopt innovation management practices as in other sectors and drive the research proactively. This is also emphasized by the fact that almost half of the reviewed papers mentioned innovation without any reference to a specific product/ service or process.

Conclusions and future research

A literature review was conducted on innovation at airports to examine the airport-innovation research framework. There, the areas of interest and types of innovation were structured with respect to journal name, innovation type, degree of innovation and its origin. The main aim was to identify the main focus of studies on airport innovation and to categorize these studies accordingly. This indicated trends and gaps in the literature, thus this study provides a guide in airport innovation for practitioners as well for future studies. Since there was no previous review on this search criteria, it is intended to expand the existing literature. Practitioners can use this study to create or enhance their innovation strategies.

It was found that the majority of the research originated from Europe. Majority of the papers were published recently, indicating a rising trend in innovation at airports. The search was made across all journals, but

mainly publications in aviation related journals were concerned with innovation at airports. Moreover, most of the researchers published only a limited number of innovation papers. This indicates that innovation generalists have to work closer with aviation professionals. Here a clear research gap can be seen for airport innovation. This could be covered by innovation scholars entering in the airport field, aviation scholars studying airport innovations or even a multidisciplinary research team with experience of innovation and airport management.

Usually, general innovation literature has a balanced distribution across product/service-, process-, marketing- and organizational innovation. However, when looking at airport innovation, majority of the literature addressed subject innovation compared to object innovation. The research of new products, new services and market innovation was not well covered in the literature. Therefore, they can be clearly areas to be analyzed and improved in the future.

Then, based on the research findings, the airport industry seems to utilize technologies from other industries, which are leveraged into optimization of existing processes. On the one hand this is a strength, since it indicates technology transfer, but on the other hand it might be a weakness, since it might imply that there is no cooperation with external stakeholders to reengineer processes. Thus, airports should engage in strategic thinking beside daily proactive operations that reengineering and bold innovation should be driven by the technology and the market. This can assure that airports utilize systematic innovation that ad-hoc efforts become daily routine.

Some object innovation examples were found, where new services based on ICT were offered such as self-service technologies, navigations services or mobile applications. This might be understood that new product/service development is given a high priority by airports, but many of these cases were simply subject innovation cases implementing ICT in existing or enhanced processes. So, on the one hand totally new products/services are missing, but on the other hand the ICT is leveraged for customer experience, which is positive. The experience economy is present in aviation, and innovative airports tend to co-create value with the passengers in an open context with open structured facilities, i.e. they try to reduce boundaries and form products/services in collaboration with the passenger. Together with the digital connectivity, this can deliver the inclusion of the passenger in the process. The passenger, in addition to being a consumer, is then upgraded in innovative airports to a content provider. This is an important transformation and airports would be advised to take advantage of it.

Then a content analysis was made to cluster the papers, resulting in the categorization of innovations at airports into general Objectives, Design, ICT and Performance Measurement. 53% of the work was classified in subcategories as general innovation, while design innovation was second with 19% followed by ICT and performance measurement with 15% and 13% respectively. It was seen

that security was a significant innovation area across all these subcategories.

Independent of the place of origin or the subcategory, incremental innovation was found to be more frequent. Considering that many leading companies might lose their position when not managing disruptive technologies adequately, this can become a threat for many airports. Again, apart from the usual business practice of focusing on market pull, forthcoming game-changers in the form of market changes and disruptive new technologies should be looked at and included in strategy. This requires proactive airport professionals, who collaborate more with researchers from distinct sectors for product/service development. To exemplify, those major developments in transportation modes can be looked at in the future. This might include alternative or complementary technologies such as Hyperloop, new aircraft types and other new technologies from Industry 4.0, which may change the constitution and the infrastructure of airports. Moreover, the potential impact of robotic technologies and cyber-physical interfaces can be looked into further to conceptualize new approaches. This involves technology scouting, which was not covered within this work but might be an avenue for future research.

Finally, this study attempts to explain which innovation approach and category was addressed by previous studies. So, it is aimed to indicate research trends by emphasizing different information such as publication years of studies and geographical regions. The literature assessment was made by the keywords innovation and airport applied in the papers in Elsevier's Scopus database. Since this was made in English Language and it was only utilizing the title, abstract and keywords of the papers there might be limitations in this context. Since the literature review did not cover innovation efforts of airports disseminated by conferences or industrial magazines, there is a restriction, which is described in the method section as well. Then, there can be also unreported innovation efforts of airports. This could be an area for future research, utilizing reviews with a new set of keywords or search criteria and new samples. However, having a high number of papers it is assumed that the statistical significance and the validity are given.

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