

The Evolution of Airport Strategic Management: A Study of Airport Strategic Management in 1947-2022 Using Content Analysis Approach

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ABSTRACT

This study analyzes the evolution of airport strategic development research by addressing two key objectives: examining changes in the focus and content of airport strategic management studies over time, and identifying influential studies that have shaped the field. A total of 375 publications related to airport strategic management were reviewed, utilizing a combination of quantitative bibliometric techniques and qualitative analysis to capture trends and significant contributions. Articles were sourced from Google Scholar and Crossref, and keyword classifications were developed based on citation patterns. This approach highlights the historical trajectory and emerging directions in airport strategic planning, revealing trends in areas such as airport economics, terminal design, sector deregulation, model development, adaptive strategic planning, integration with regional development, aviation industry dynamics, and COVID-19-related adjustments. Content analysis provided further insight into these focal areas. Notably, Wijnen (2008) was identified as a prolific author in the field, while Kwakkel et al. (2010) produced the most cited work, titled "Adaptive Airport Strategic Planning". The findings offer valuable insights into the field's development and potential future research directions.

Keywords: Airport Strategic Management; Airport Strategic Planning; Bibliometric Technique; Content Analysis; Keywords Analysis

INTRODUCTION

Recognizing the evolution of strategic management literature related to airport strategic management through a content analysis approach on studies taken from Google Scholar and Crossref (Cross references) became the purpose of this research. This study investigated the historical development of structure and evolution of airport strategic management studies and predicted the development of airport strategic management over the years. Understanding airport strategic management was expected to give an insight to which direction the airport strategic management will be developed in the future.

Two main questions; namely, how are the content and evolution of airport strategic management studies over the years? Which studies significantly contributed to the evolution of airport strategic management? are expected to answer in this study. To understand the development of airport strategic management over the years, this study searched airport strategic management keywords in platforms that provide comprehensive articles and journals related to the predetermined topic. The results were then tabulated and ranked to identify the title, author, and citation.

This study, which investigates the structure and evolution of airport strategic management, concentrated on the three important aspects, namely data, analysis, and scope of the study. This study used quantitative data to be complemented with qualitative interpretation that reflected subjective perspectives. Both approaches were expected to complement one another to validate or support the interpretation of previous studies. Citations of previous studies are the main materials for bibliometric technique that employed in this study to analyze the structure and evolution of airport strategic management to develop keywords that would be used to classify related airport strategic management studies over the years.

The results of airport strategic management studies on Google Scholar and Crossref could provide perspective on the ongoing theoretical and empirical studies related to airport strategic management. By identifying and understanding the evolution of the studies of early airport strategic planning literature, historical context can be obtained. In addition, it can also provide insight into the future of the literature by understanding the direction and trend of keywords and themes used in the development of airport strategic management studies.

LITERATURE REVIEW

In order to understand the future of airport strategic management studies, it is necessary to comprehend the historical and evolutionary perspectives in developing airport strategic management practices. In the beginning of the emergence of the aviation sector, military and defense interests tend to determine how airports are built. As the second world war ended, the demand for air travel services increased. Consequently, more and more airports were needed to accommodate for the increase in air travel. At this time, airport standardization began to emerge. Airport infrastructure development has started to be worked on seriously and formally by involving more stakeholders, not only the military. The necessity for an airport planning and development process along with its investment calculation led to the production of airport master plans.

The development of an airport master plan aims to produce guidelines for an integrated airport construction following the economic and transportation development plan while considering its environmental impact on the region. An airport master plan can be the

evidence of the airport's commitment to performing business and providing good service. In 1947, Wright published a study entitled "Economical Airport Planning". In his study, Wright concluded that the most important objective of airport planning is setting a standardization for an adequate airport to accommodate current and future aircraft through a number of effective and efficient airport development projects following the assumed economies of scale. The airport planning standard can be formulated by the aviation industry representative committee and technical society, who coordinate airport and aircraft design to help civil aviation authorities in setting a standard that governments can follow in constructing suitable airports (Wright, 1947).

The air transportation industry experienced relatively predictable and controlled growth During the period of centralized economic regulation. Due to the characteristics of the industry which are considered formularized and capable of being directed or influenced, airport stakeholders still have confidence to use the formal airport master plan in formulating airport strategic planning. The airport development and air traffic level depended heavily on the regulators of the given era. The function of airport management was seen as a service provider and a public facility. Government funds could be used to cover risks for the sake of broader benefit and value from an adequate air transport system. Regulators have the power and tend to be able to determine prices and rates in the aviation sector which in turn can determine prices and how the business and competition runs. Improving the transportation function is the main focus of airport strategic planning. Airport planning also aimed to explore potential integrated coordination with the transportation planning (Post, 1956).

The liberalization of airline economy had encouraged the aviation industry to set fares and flight frequencies more independently. Airlines might enter and leave routes at the discretion of their respective companies. Airlines competed on price and service quality; these had pushed the airline industry to be more market oriented. This change made it relatively difficult for airports to predict the demand that should be anticipated. Airport planning underwent a substantial evolution of perspective during the 1970s. The need for high-speed long-distance transportation led to the introduction of commercial turbojets in the late 1950s. It was feared that the airport capacity shortage would occur because in the 1960s the stakeholders involved in the airport industry projected a strong industrial growth rate. Stakeholders related to airport planning felt that the inability to meet airport capacity requirements could slow down the growth of airport sector. In the end, this concern never fully materialized. Economic factors and quota policies had proven effective in anticipating the problem of congestion and queues of planes or passengers at airports. In addition, the implementation of demand forecasting and capacity assessments, the emergence of airport dependence on technology and automation, and airport concept selection had significantly changed the airport planning process (Goodwin, 1977).

In its development, airport development master plan had become the main element of airport planning. The master plan concept relied heavily on the best forecasting process to produce a good planning, implementation, and target. Assumptions and forecasting analysis related to the airport master plan such as airport traffic, infrastructure requirements, the necessity for new technology adoption, and implementation plan often showed that all initial forecasting data were wrong and far from the actual conditions. In the end, the master plan was considered unable to be used as a benchmark for the airport's future blueprint. A more realistic airport planning process was needed. Airport planning should assume the airport industry as an industry that is full of uncertainties. Airport planning also needed to encompass flexibility that enables the airport management to grasp every new opportunity. Airport management could change its

airport planning policies by changing traditional airport master plan with a more preferable approach toward dynamic strategic planning (Maldonado, 1990).

It is undeniable that deregulation in the aviation sector has had an impact on airport traffic. Airport traffic volatility before deregulation compared to after regulation was 4.15 for all American airports. This volatility figure tells us that airport traffic is increasing or decreasing by 4% compared to the long-term trend annually. This volatility was measured from the trend that occurred; the volatility did not measure the traffic difference with the airport management's assumed projection, the basis for the measured volatility was the data trend. The difference between actual and projected airport traffic was about +20% in five years (de Neufville, 2006). Maldonado (1990) found that the average error in airport traffic projections was +/- 23%, 34%, and 76% respectively for the projection of 5, 10, and 15 years in the United States (de Neufville, 2006).

The aviation sector was rapidly changing towards liberalization, deregulation, and privatization. Airport operators should be able to respond to these dynamics according to the function, scale, and political jurisdiction of the airport. Airport management must always develop airport strategic plans that are able to identify trends and volatility in demand for air transportation. Strategic planning also includes how every long-term development with a large amount of initial investment issued by the airport for development according to business dynamics will not have a negative impact on safety, sustainability, profitability, and survivability of the airport. In general, there was no single and uniform effect of airport liberalization, deregulation, and privatization. Airport liberalization, deregulation and privatization have had mixed impacts. The effects felt by an airport or even in a country can differ from one another based on the type, size, scale, as well as the nature of the airport. The impact felt also varies in a country based on the system of government or especially on the economic system types. Airport operators must be able to analyze carefully the impact of liberalization, deregulation and privatization on airports. The appropriate response and reaction from airport operators are expected to optimize the airport's position in relation to industrial changes. The airport managerial and administrative environment is made flexible enough so that managers can make the best decisions that can advance the airport industry in line with the liberalization that has occurred in the air transportation industry. The airport's managerial and administrative environments are designed to be adaptable, allowing managers to make optimal decisions that would enhance the airport industry in alignment with the liberalization that occurred in the air transportation industry (Ashford, 1994).

How to develop and expand airports in the long term of around next 15-50 years is generally the main discussion of airport strategic management activities. In order to formulate a strategic management that capable of providing an overview and future scenarios, collaboration between researchers and practitioners across disciplines began to develop a kind of decision-making model. The development of systems and models is intended to assist airport operators in expanding and optimizing airfields such as aprons, taxiways, and runways. Besides that, it is expected that the operating procedures and tactics of market demand management strategies such as (allocation and slot control) can be assisted by the model. The ability to forecast every service level implication at the airport from countless scenarios and different hypotheses about future industrial conditions is a key requirement to planning at a strategic level (Usman et al., 2023).

Practitioners, researchers, aviation authorities, and airport operators collaborated to develop a decision support system that would be made by decision makers regarding the airport's strategic planning. Creating a reliable assistance system for airport operators and managers is the main goal of model development. Airport managers must

be able to optimize both existing and forecasted demand along with their derivative service levels. It was hoped that the establishment of decision support system (DSS) enables airport operators to perform the required airport planning analysis quickly, reliably, even in all limited conditions (Zografos & Madas, 2007).

Several simulation models have been developed (such as, SIMMOD, TAAM, and the Airport Machine) tended to be microscopic which was not suitable to be used by airport managers and operators to save and optimize a lot of time, effort, and costs in making airport strategic planning decisions. The developed models also had a learning curve that took a long time and required well-trained users. Using those models requires a lot of efforts, sacrifices, involved crews, and costs to simulate an airport with a large number of trials. Finding the optimal scenario requires a long time to be implemented, to achieve it, it must first modify airport assumptions with various scenarios (Zografos et al., 2013a).

Complexity, uncertainty, and continuous changes are the main characteristics of airport operations and airport business dynamics. In dealing with the trend of demand for air transportation, airport operators take various strategic approaches that are deemed most in line with the rules and regulations at the place where airports operate, and are adapted to the characteristics and types of airports they manage. Tardiness and negligence by airport operators in adjusting the airport capacity to market demand could hinder the airport growth. System dynamics that offer an understanding of the nonlinear behavior of complex systems over time have begun to be proposed by researchers and practitioners in developing airport strategic planning models. The implementation of system dynamics model in airport strategic planning aimed to apply an airport model that to be able to change and adapt its business model and airport operations quickly, easily and flexibly in dealing with various challenges. The model that has been developed encompasses the primary operations conducted at an airport, illustrating the interconnections and dynamics between aircraft movements, passenger numbers, infrastructure expansion, capacity, cash flow, and projected growth. Therefore, long-term decision-making possesses a greater degree of measurability.

In order for airport management's decision making to be more measurable, the model developed must be able to accommodate a comprehensive range of key airport activities. This entails illustrating the interconnections and dynamics among various factors such as aircraft movements, passenger volume, capacity, infrastructure expansion, financial flow, and anticipated growth (Bießlich et al., 2014).

Formulating airport capacity involves complex calculated metrics, especially when the operator aims to evaluate the airport expansion strategic plan. The related supporting infrastructure available around the airport is an essential factor in determining how the airport is expanded. The physical development model of an airport can be influenced by its operational characteristics, such as whether it is an international airport, a hub airport, or a cargo airport. How can airport capacity, the level of delays that occur at airports, and other complex variables that can be modified one another become a set of factors forming airport throughput. The distribution of demand for air transportation services depends on many things, including competition between airlines, technology and types of aircraft used on certain routes, operational income, route complexity, other related airport characteristics, even small changes that occur at airports elsewhere in terms of changes in capacity, can affect how the demand for air transportation services. In aggregate, airport infrastructure development can improve connectivity, and provide broad economic benefits, although negative externalities will arise such as noise and local pollution. Modeling demand control slot and airport allocation will determine how

infrastructure development and expansion of airports along with the impacts that may arise (Rodríguez-Sanz et al., 2022).

Airport strategic planning is closely related to risk management. The management of airport strategic planning must be able to minimize the possibility of building assets that ultimately have a small benefit (underperformed assets). Airport managers are also faced with the risk of public unrest related to the impact of aviation on climate change. Airport managers are also faced with the risk of facilities becoming obsolete with time due to the pace of technological development. The recent pandemic forced the new business model development which allows minimizing the movement of people and goods which also challenges the airport's adaptability, as happened recently during the Covid-19 pandemic, where airports suffered huge losses. These challenges require managing the airport's strategic planning beyond its traditional boundaries so that the airport is able to seize wider opportunities, have new frameworks, and adopt different ways of thinking (Hasaneya et al., 2023).

RESEARCH METHOD

This study started by searching the contents of airport strategic management literature, tracing the theoretical evolution of airport strategic plans, and identifying the primary research topics related to airport strategic management. To execute all those stages, this study employed a content analysis approach to airport strategic management articles on Google Scholar and Crossref. The content analysis approach was used to explore the objective, systematic, and quantitative considerations of the published articles. Moreover, the content analysis was expected to provide information regarding the interpretation of research directions and the evolution of airport strategic management over the years.

The first step in the content analysis was selecting the articles to be analyzed. Because this study focused on the concept of airport strategic management, every article published between 1947-2022 was selected on the Google Scholar and Crossref using Harzing's Publish or Perish software. The selection was performed by only selecting articles that explicitly discussed airport strategic management. The software functioned by examining the title, abstract, and keywords of each article. A total of 375 articles were identified and selected. Actually, the search managed to find 384 articles, but the year of publication on some articles could not be identified; therefore, nine articles were excluded. Table 1 below shows the number of articles and their classification.

Table 1. Article Search Results, Classified based on the Year of Publication

No	Year	Number of Articles
1	1947-1979	28
2	1980-1989	10
3	1990-1999	31
4	2000-2009	92
5	2010-2019	150
6	2019-2022	64
Total		375

After classifying based on the year of publication, it was found that 42% of the total articles used as research material were published between 1947 and 2009, while 40% were published between 2010 and 2019, and the rest were published between 2020 and 2022, an overview is presented in Table 1 above in detail.

Figure 1 depicts the distribution of scientific papers over the years. Based on the data presented, it can be observed that the initial publications emerged in the 1990s, while a significant surge in growth occurred subsequent to 2005. Three stages can be identified in the publication trend. During the initial phase spanning from 1995 to 2004, the number of studies conducted annually was below 10. The subsequent phase encompassed the years 2005 to 2012, during which there was a gradual increase in the number of studies conducted, albeit remaining below 50 studies annually. In the third stage, spanning from 2013 to 2019, there was a notable rise in the quantity of publications, with the figure escalating from 62 to 101. The observed trend indicates a consistent annual increase in the number of publications, culminating in its highest point in the year 2019.

Figure 1. Concept Map of Publication Keywords Related to Airport Strategic Planning throughout 1943-2022 using VOSviewer (Classified based on Density)

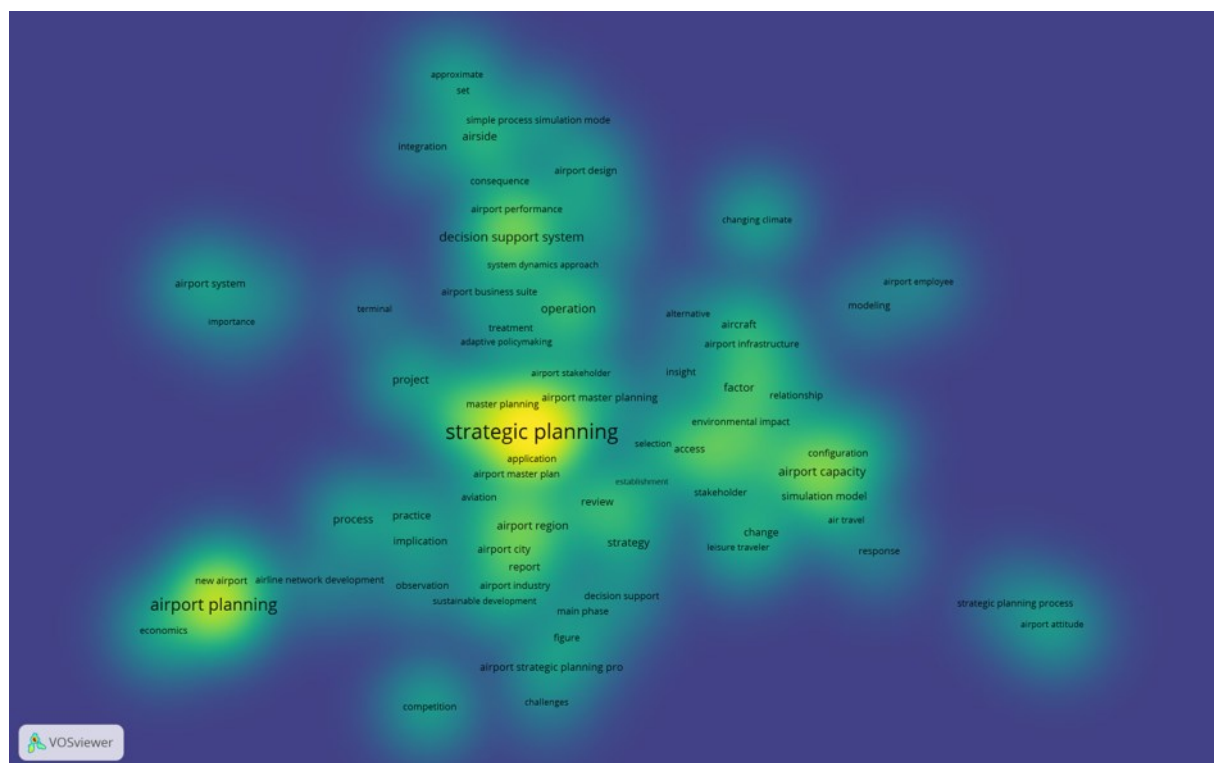


Table 1 can also provide information regarding the distribution of scientific articles over the years. Based on **Table 1**, the first publication was published in 1947, and for the course of 30 years, until 1979, there were 28 articles published. During 1980-1989, 10 articles were published, and then 31 articles in 1990-1999. The substantial growth started to occur throughout 2000-2009 in which there were 92 articles published or nine articles per year. The next publication trend reached its peak in the 2010-2019 with 150 published articles or 15 articles per year. The number of airport strategic planning studies are growing moderately but it is still less than 50 studies per year. Finally, throughout 2019-2022, the number of published articles were 64 or around 16 per year. Therefore, it can be concluded that the number of airport strategic planning publications are increasing every year and are relatively growing.

RESULTS

Determining Concepts or Keywords

To analyze the contents of 375 selected articles, it was necessary to determine a list of keywords or concepts that became the main theme of this study. Of the 375 publications on airport strategic management, 155 most frequently keywords were identified and closely related to each other. The necessary information that was included in the document to meet the requirements consisted of the year of publication, the journal in which it was published, the title of the document, the author's name, their affiliation, keywords associated with the document, the document type, an abstract summarizing its content, and the number of citations it received. This information was exported into a CSV format. The date of retrieval was March 14, 2023. The analysis of co-authorship, co-occurrence, citation, bibliographic coupling, co-citation, and themes was conducted using VOSviewer (version 1.6.18). Two commonly used attributes, referred to as the "link attribute" and the "total link strength attribute", were utilized.

Figure 2. Concept Map or Publication Keywords on Airport Strategic Planning throughout 1943-2022 using VOSviewer

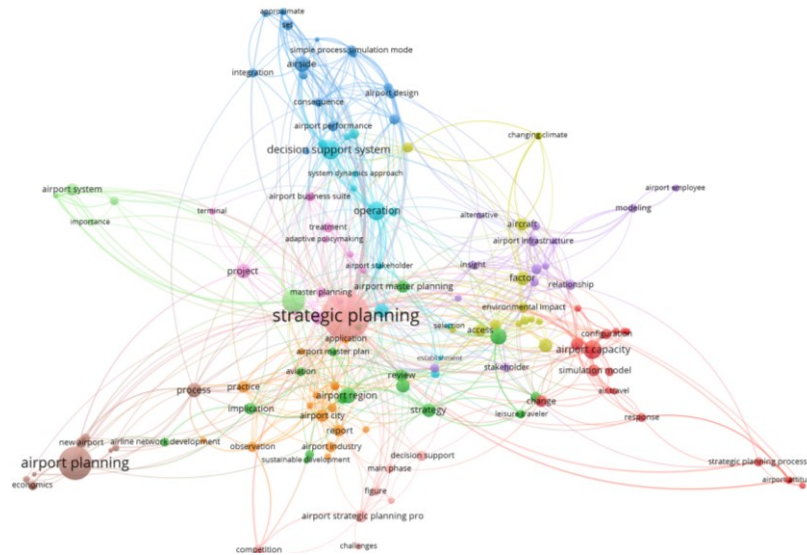


Figure 2 above shows the distribution of concepts or keywords in publications regarding the airport strategic planning throughout 1943-2022. The difference in node color for each concept or keyword signifies its cluster or classification. Co-occurrence of concepts or keywords is the frequency in which the keywords occur together. The node size shows the occurrence frequency, the larger the node size, the more these keywords appear. The curve between nodes represents their common occurrence in the same publication. The shorter distance between two nodes reflects more occurrences of the two keywords.

Table 2. Concept Distribution based on Clusters for "Airport Strategic Management" Keyword on Google Scholar and Crossref Database in 1943-2022

Cluster 1	air travel, airline, airport attitude, airport business, airport capacity, airport capacity prediction, change, configuration, crisis, delay analysis, entire population, explicit consideration, look, probabilistic airport capacity prediction, response, simulation model, stochastic analytical model, strategic planning process, survey, weather forecast uncertainty
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Cluster 2	adaptive airport strategic planning, airline network development, airport master plan, airport master planning, airport region, airport systems planning, aviation, aviation industry, evolution, implication, leisure traveler, proposal, review, strategy, sustainability, sustainable development, urban development
Cluster 3	airport airside, airport design, airport performance, airside, alternative future, approximate, capacity management, challenging task, compatible models, consequence, effect, integration, landside, set, simple process simulation model, variety
Cluster 4	access, aircraft, airport operation, airport strategic planning problem, airport terminal, changing climate, computational experiment, efficacy, environmental impact, factor, identification, logistic depot planning, low-cost airline, maintenance cost uncertainties, regional development, repair
Cluster 5	airline behavior, airport employee, airport infrastructure, airport operator, alternative, choice behavior, delay, fact, goal, insight, modeling, relationship, solution, stakeholder, year
Cluster 6	airport modeling, airport stakeholder, airport terminal planning, decision support system, demonstration, establishment, evaluation, formulation, integrated use, landside model, operation, policy maker, selection, system dynamics approach
Cluster 7	airport city, airport industry, application, critical review, designing, face, guidance, implementation, key issue, observation, practice, report, spatial development, user, world
Cluster 8	airport planning, comparative analysis, decision support suite, deregulation, economics, evolving context, new airport, new approach, output, process, regional airport system planning, strategic quality management
Cluster 9	adaptive policymaking, airport business suite, airport strategic exploration, dominant approach, forecast, long term development, master planning, project, recommendation, separation, terminal, treatment
Cluster 10	air transportation industry, airport strategic planning process, challenges, competition, current airport strategic planning, decision support, economic conflict, figure, main phase, strategic planning
Cluster 11	airport system, dynamic evolution, importance, infrastructure, low-cost carriers, growth, mechanism, uncertainty

Table 2 above shows bibliographic coupling from publications that were used as references of this study. The analysis successfully classified 11 clusters from the keywords determining process. Cluster 1, in pink, contains 20 concepts or keywords. Airport capacity prediction is one of the main factors that is important in a good airport management. Inaccurate capacity prediction causes unnecessary delays in both the airside and landside, and contribute to inefficiencies in the air traffic management. Accurately predicting airport capacity is a relatively difficult task because that is based on a number of interconnected factors, including operating standard and procedure, runway configuration, meteorological condition, and air transportation demand. Various concepts and keywords in Cluster 1 are related to the development of airport strategic demand with projection approach and predicting the airport capacity accurately.

Cluster 2, in green, contains 17 concepts and keywords. Strategic planning related to airport design and operation is not an easy task because it must consider several alternative scenarios in the future. Airport strategic planning calculates strategic choices and its consequences towards the airport performance to ensure that the airport achieves targets and goals that have been set. Airport strategic planning tries to formulate what is the baseline performance of the current airport, how is the airport performance if it is implementing the existing business strategy (business as usual), how airport expansion will affect the airport performance, the effect of new strategy on airport performance after its implementation, how a change in the dynamics of the airline industry will affect the airport performance, how are the level of current indicators of performance such as airport capacity, delays, noise, third-party risk, and airport cost-benefits, and what are the desired performance level in the future. Concepts and keywords related to strategic planning including an assessment of its implementation are included in Cluster 2.

Cluster 3, in blue, contains 16 concepts and keywords. Airports are experiencing increased demand volatility in air traffic because the air transport industry tends to be more competitive. In addition, the Covid-19 pandemic added uncertainty to the airport sector. Various management techniques can be performed to anticipate the uncertainties that interfere with the airport strategic planning process. Airports must conduct development scenario analysis related to the aviation industry as well as the analysis of threat triggers and opportunities in the airport business environment (Wai et al., 2019). Master plan strategy and airport diversification are expected to produce a planning that is flexible and has strategic responsiveness and financial resilience to various uncertainties faced by airports. Scenario simulations of various external and internal aspects of an airport are the concepts and keywords included in Cluster 3.

Cluster 4, in yellow, contains 16 concepts and keywords. Airport construction is increasingly challenging due to uncertainty in future developments. Airport development, which relies on airport master plan, aims to provide a detailed blueprint of how the airport is supposed be in the future and how to achieve it. Nevertheless, due to uncertainty, sometimes the master plan cannot be used as a guideline. An alternative to airport master plan is to have a plan that is flexible and adaptable to changing conditions in which the airport has to operate. Adaptive airport strategic planning is prepared by applying exploratory modeling and analysis, which employ computational experiments, to measure the effectiveness and efficiency of airport strategic planning in various future conditions. Minimizing risks through adaptive airport strategic planning become concepts and keywords included in Cluster 4.

Cluster 5, in purple, contains 15 concepts and keywords. Airports have interrelated and complex operational and strategic processes that involve many stakeholders. Timeliness

and schedule are some of the main outputs of airport services. Performance in terms of timeliness and schedule requires cooperation and collaboration between airport managers, airlines, government, security guards, and other related stakeholders. Concepts and keywords related to timeliness, delay, and airport stakeholders are included in the Cluster 5.

Cluster 6, in yellow, contains 16 concepts and keywords. The airport planning and decision-making processes involve many factors and functions that can be conflicting one another. When pursuing one target and objective, the target and objective on the other hand will be negatively affected. Finally, a number of simulation models is developed as a decision support tool to accommodate various aspects, interests, and airport performance indicators such as capacity, noise, delay, security, safety, and cost effectiveness. Airport managers can utilize decision support tools that can give an integrated view of airport operations (both the airside and the landside). Cluster 6 contains keywords or concepts related to model formulation in assisting decision-making at airports.

Cluster 7, in orange, contains 15 concepts and keywords. Literature reviews on airports related to their relationship with urban scientific planning are still relatively rare. In fact, the airport has a historical role in shaping metropolises. The airport's transformation into an aviation-oriented node has underlined the airport's significance as an agent of change and a product of globalization. Airport spatial model in relation to the objectives of sustainable urban development is developed into an airport master plan and a broader urban planning strategy. The concept of developing airports and cities (airport city) is the keyword and concept included in Cluster 7.

Cluster 8, in red tosa, contains 12 concepts and keywords. The regulatory situation in the aviation industry has changed. One major element of this change is the aviation market deregulation. With deregulation, bilateral regulation of air services and tariff regulations are gradually replaced by a limited competition regulatory regime. As a result, airlines are developing new network strategies. Airport operators must differently think about airport capacity planning and development. Changes in flight patterns and the consequences of airline network behavior are included in Cluster 8.

Cluster 9, in violet, contains 12 concepts and keywords. The airport industry is characterized by its dynamic nature, intense competition, and inherent unpredictability. The progress of a significant airport is contingent upon its capacity to effectively balance business realities, long-term expansion requirements, and societal considerations. It is essential for airport managers to promptly engage in the examination of prospective scenarios and policy alternatives. Airport managers also need to increase their understanding and insight into key business drivers and risk factors, as well as produce information for efficient, effective and consistent decision-making. The airport planning exploration study is included in Cluster 9.

Cluster 10, in pink tosa, contains 10 concepts or keywords. Airports need a good strategic plan in their efforts to expand domestic air service level and pursue new regional and international services. The process of airport strategic planning is characterized by its dynamic and continuous nature that involves wider participation from stakeholders who are directly or indirectly involved in airport operational activities. The airport strategic planning process needs to consider external and internal aspects which are the concepts or keywords in Cluster 10.

Cluster 11, in light green, contains seven concepts and keywords. Airport management adjusts to the adoption of the Low-Cost Carriers (LCC) system as a growing segment in the aviation market. In fact, the impact of LCC has spread to most commercial airports both primary and secondary. However, apart from the evolution of airline network system, the dynamics of airport system evolution in response to LCC growth requires an evolutionary process of airport strategic planning which must also be adjusted. Concepts and keywords related to airport dynamics in responding to the challenges of LCC growth are included in Cluster 11.

The eleven clusters above can be used as a reference for concepts or keywords that discuss airport strategic planning. Each cluster establish the theme of airport strategic planning. The eleven clusters above can be used to understand the approaches used in 375 publications related to airport strategic planning.

The concept map presented in [Figure 1](#) offers a visual representation of the key themes and trends in airport strategic planning research over the past several decades. Using VOSviewer, a prominent tool for bibliometric analysis, the map classifies publication keywords based on their density, highlighting the evolution and focus areas within the field. This approach allows for a comprehensive understanding of how research topics have shifted and which areas have gained prominence over time.

Classification of Concepts or Keywords Based on Publication Period

Based on 375 selected publications in this study, the most frequent concepts or keywords that are interrelated with other concepts or keywords are strategic planning, airport planning, uncertainty, decision support system, operation, airport capacity, and adaptive airport strategic planning, respectively. The following [Table 3](#) shows the trend of concepts or keywords on airport strategic planning publications throughout 1947-2022.

Table 3. Concepts or Keywords Evolution Over the Years

Year of Publication	Discussed Concept or Keywords
1947-1990	economics, airport
1990-1995	airport terminal planning
1995-2000	deregulation, airport systems planning, regional airport system planning, evolving context, simulation model, landside, airport planning
2001-2005	review, figure, designing, set, airport business suite, airport strategic exploration, delay analysis, approximate, compatible models, airport system, forecast, integration, airport attitude, entire population, survey
2006-2010	process, project, air travel, crisis, goal, airport business, treatment, airport stakeholder, policy maker, demonstration, integrated use, landside model, adaptive policymaking, current airport strategic planning, year, look, airline behavior, strategic planning process, decision support system, airside, evaluation,

Year of Publication	Discussed Concept or Keywords
	response, output, long term development, separation, selection, aircraft, airport design, airport capacity, infrastructure, system dynamics approach
2011-2015	application, change, strategic planning, urban development, environmental impact, airport industry, sustainability, airport operator, airport master planning, observation, implication, user, airport strategic planning problem, competition, operation, decision support, insight, capacity management, comparative analysis, report, stakeholder, airport performance, probabilistic airport capacity prediction, sustainable development, airport modeling, uncertainty, delay, challenging task, airline, airline network development, consequence, terminal, low-cost airline, configuration, airport terminal, variety, challenges, airport capacity prediction, guidance, airport airside, airport infrastructure, simple process simulation model, alternative future, alternative, practice, access, spatial development, stochastic analytical model, weather forecast uncertainty, computational experiment, decision support suite
2016-2019	new approach, airport region, airport strategic planning process, fact, modeling, aviation, new airport, airport city, adaptive airport strategic planning, efficacy, face, solution, dominant approach, airport employee, choice behavior, strategy, master planning, formulation, airport operation, relationship, explicit consideration, leisure traveler, regional development, main phase, effect, proposal, key issue, dynamic evolution, low-cost carriers growth, mechanism, airport master plan, importance, identification, factor, aviation industry, evolution, changing climate, logistic depot planning, maintenance cost uncertainties, repair, strategic quality management
2020-2022	Implementation, recommendation, world, critical review, establishment, air transportation industry, economic conflict

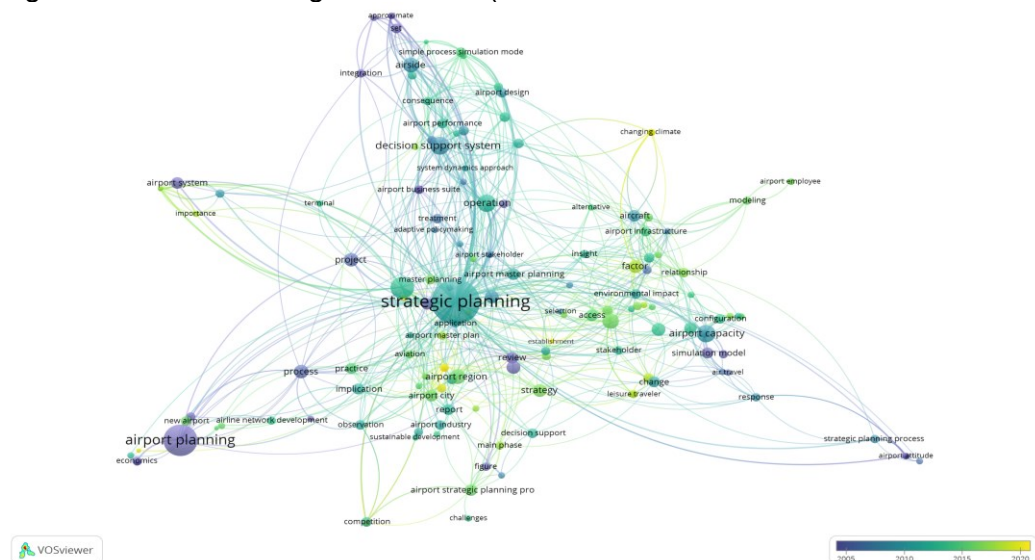
Table 3 shows the literature reviews of concepts or keywords and are classified based on the year of publication. Classifying concepts or keywords based on the year of publication is useful in evaluating trends in publications that discussed airport strategic planning throughout 1947-2022. Until 1990, publications on airport strategic planning

mostly discussed the concept of airport economics. In 1990-1995, airport strategic planning literature focused on the concepts or keywords of airport terminal planning. Throughout 1996-2000, the literature on airport strategic planning was dominated by the concept or keywords of airport sector deregulation and its relation to airport system planning and the emergence of airport simulation models. The development of airport strategic planning literature during 2001-2005 led to discuss airport strategic exploration, efforts to predict future airport development, and the search for a valid airport model. Furthermore, in 2006-2010, the airport strategic planning studies focused on adaptive airport strategic planning. During this period, studies related to airport strategic planning also began to adopt the system dynamics approach as a tool for determining scenarios and sensitivity analysis in preparing airport strategic plans. Moreover, airport strategic planning studies began to experience integration with city, metropolis, and regional development plans in 2011-2015. Airport development considered the sustainability aspects of regional and spatial development. In 2016-2019, airport strategic planning studies discussed the dynamics of aviation industry. In this period, the studies focused on development of low-cost carriers (LCC) and stakeholders' behavior in the airport industry, including passengers, travelers, employees, logistics, retail, and all parties involved in airport operations. The airport strategic planning literature during the Covid-19 pandemic (2020-2022) discusses a lot of concepts or keywords related to adjusting physical capital, which experienced quite large adjustments, especially in airport and aircraft infrastructure because the supply chain might become more local than global after the pandemic. The pandemic changed the nature of globalization in the post-pandemic world (Bharatish et al., 2023).

By classifying the literature's concepts and keywords based on the year of publication, the evolution of subject and trend of airport strategic planning studies based on the period can be studied. According to the [Table 3](#) above, the classification shows the primary research topics of airport strategic planning which were discussed over the years. This detailed timeline is useful to increase our understanding of the evolution of the airport strategic planning in terms of research agenda and the shift in research paradigms to be mapped over the years.

Figure 3 below shows VOSviewer's output concerning the distribution of concepts or keywords based on the year of publication.

Figure 3. The Map of Publication Concepts or Keywords on Airport Strategic Planning throughout 1947-2022 using VOSviewer (Classified based on the Year of Publication)



The Number of Publications and Research Citations

In the development of a literature, key individuals, who become one of the most important factors and contribute to scientific development of the field, can be identified. Researchers' characteristics have the power and impact towards the development of scientific studies in their works. Individuals who publish a large number of scientific studies in one period have a strong influence on the themes studied in the next period. Therefore, it is important to identify researchers that publish numerous scientific studies related to airport strategic planning to comprehend the evolution of strategic planning in the past and predict the direction of its evolution in the future.

The number of articles published by researchers depends on their career in devoting themselves into the study of airport strategic planning. The author with most publications can be assumed as the most influential researcher in the structure and evolution of airport strategic planning. These authors have a strong influence on the evolutionary direction of the study. The authors' influence was not only caused by the number of articles they wrote, but also due to the impact of several articles which became a reference for further research.

Table 4. The Number of Articles Based on the Author

Author(s)		Number of Articles
1.	RAA Wijnen	19
2.	KG Zografos	17
3.	JH Kwakkel	11
4.	Robert E. Caves, Geoffrey D. Gosling	11
5.	Alexandre L.W. Bradley	8
6.	Richard de Neufville	6
7.	R Kicinger, JT Chen, M Steiner, J Pinto	4
8.	Matteo Ignaccolo	3
9.	Jeffrey C. Price, Jeffrey S. Forrest	3
10.	Rush F. Ziegenfelder, William H. Wilkinson	3
11.	KA Kenville	2
12.	S Shuchi, R Drogemuller, L Buys	2
13.	L Magalhães, V Reis, R Macário	2
14.	K. A. Alkaabi	2
15.	OB Odediran	2
16.	William H. Leder	2
17.	Dave Tomber, Harley Moore, Bob Griebenow	2
18.	Mike Brown	2

Articles that were frequently cited in airport strategic planning studies are assumed to accelerate the development of the airport strategic planning literature. Therefore, it is important to identify the most influential airport strategic planning article published on Google Scholar and Crossref between 1947 and 2022 in order to better understand the

direction of future development of the literature. To define and calculate the influence or impact of an article, the widely accepted citation method was employed. In this study, [Wijnen \(2008\)](#) from Delft University of Technology, Faculty of Aerospace Engineering, Delft, The Netherlands become the author with most published articles (see [Table 4](#)).

Table 5. The Number of Citations based on the Publication Title

Citations	Publication Title	Year	Reference
184	Adaptive airport strategic planning	2010	Kwakkel et al. (2010)
148	A generic system dynamics-based tool for airport terminal performance	2009	Manataki & Zografos (2009a)
136	Spatial planning models of airport-driven urban development	2011	Freestone & Baker (2011)
113	A decision support system for airport strategic planning	2004	Stamatopoulos et al. (2004)
99	Increasing airport capacity utilization through optimum slot scheduling: review of current developments and identification of future needs	2017	Zografos et al. (2017)
93	Assessing airport terminal performance using a system dynamics model	2010	Manataki & Zografos (2010)
78	Development and demonstration of an integrated decision support system for airport performance analysis	2006	Zografos & Madas (2006)
57	Evaluating terminal management performances using SLAM: The case of Athens International Airport	2007	Andreatta et al. (2007)
56	A set of approximate and compatible models for airport strategic planning on airside and on landside	2016	Andreatta et al. (1999)
54	Planning, sustainability and airport-led urban development	2009	Freestone (2009)
54	Strategic development of airport and rail infrastructure: The case of Singapore	2003	Phang (2003)
53	Assessing the Efficacy of Dynamic Adaptive Planning of Infrastructure: Results from Computational Experiments	2012	Kwakkel et al. (2012)
47	Simulation-based turnaround evaluation for Lelystad Airport	2017	Mota et al. (2017)
46	Tackling uncertainty in airport design: A real options approach	2007	Chambers (2007)
38	Decision support for airport strategic planning	2008	Wijnen et al. (2008)

35	Location planning for dynamic wireless charging systems for electric airport passenger buses	2018	Helber et al. (2018)
35	Airport capacity prediction with explicit consideration of weather forecast uncertainty	2016	Kicinger et al. (2016)
34	Evaluating the strategic design parameters of airports in Thailand to meet service expectations of low-cost airlines using the fuzzy-based QFD method	2020	Pandey (2020)
32	Management and planning of airport gate capacity: A microcomputer- based gate assignment simulation model	1986	Hamzawi (1986)
31	Modelling and managing airport performance	2013	Zografos et al. (2013a)
31	Multi-objective airport gate assignment problem in planning and operations	2014	Kumar & Bierlaire (2014)
30	The airport business in a competitive environment	2014	Jimenez et al. (2014)
30	A decision support system for total airport operations management and planning	2013	Zografos et al. (2013b)
30	Modelling airport congestion charges	2005	Janic (2005)
30	Airport systems planning	1976	de Neufville (1976)
29	A simulation model for airport capacity and delay analysis	2003	Ignaccolo (2003)
28	Development of a runway allocation optimization model for airport strategic planning	2008	Heblij & Wijnen (2008)
27	Deregulation induced volatility of airport traffic	1991	de Neufville & Barber (1991)
24	The treatment of uncertainty in airport strategic planning	2010	Kwakkel (2010)
24	Strategic planning--an approach to improving airport planning under uncertainty	1990	Maldonado (1990)
22	Planning airport access in an era of low-cost airlines	2006	de Neufville (2006)
20	Dynamic evolution of European airport systems in the context of low-cost carriers' growth	2017	Jimenez et al. (2017)
20	Ground delay program planning under uncertainty in airport capacity	2012	Mukherjee et al. (2012)

16	Retail concessions at European airports: Commercial strategies to improve non-aeronautical revenue from leisure travelers	2018	Puls & Lentz (2018)
16	Advanced modeling capabilities for airport performance assessment and capacity management	2007	Zografos & Madas (2007)
15	Airport taxi planning: Lagrangian, decomposition	2013	Marín (2013)
15	Capacity dynamics and the formulation of the airport capacity/stability paradox: A European perspective	2010	Desart et al. (2010)
15	Airport management: a strategic approach	2007	Fernandes & Pacheco (2007)
14	Development and demonstration of a modeling framework for airport terminal planning and performance evaluation	2009	Manataki & Zografos (2009b)
13	A simple process simulation model for strategic planning on the airside of an airport: A case study	2015	Chen et al. (2015)
13	Dealing with uncertainty in airport strategic planning	2007	Kwakkel et al. (2007)
13	Integrated airport performance analysis through the use of the OPAL platform	2005	Zografos et al. (2005)
12	Airport business strategy	2018	Halpern (2018)
12	Airport strategic planning in the context of low-cost carriers' ascendancy: Insights from the European experience	2015	Perez (2015)
12	The treatment of uncertainty in airport strategic planning: The case of Schiphol Airport's long-term vision	2009	Kwakkel et al. (2008)
12	Decision support for airport strategic planning	2008	Wijnen et al. (2008)
12	A simulation-based architecture for supporting strategic and tactical decisions in the apron of Rome-Fiumicino Airport	2005	Confessore et al. (2005)
12	An organizational decision support system for airport strategic exploration	2003	Walker et al. (2003)
12	Strategic planning for airport capacity	1991	Neufville (1991)
11	Improving the management of the environmental impact of airport operations	2008	Visser et al. (2008)
11	The airport business suite: A decision support system for airport strategic exploration	2003	Visser et al. (2003)

10	The dark side of aeromobilities: Unplanned airport planning in Mexico City	2014	Lassen & Galland (2014)
10	A fast and simple model for a quick scan of airport performance	2009	Kwakkel et al. (2009)
10	Intelligent air transportation-A resource management perspective	2007	Lind et al. (2007)
10	Strategic direction in the airport business: enabling or disabling?	2001	Pitt (2001)

Based on [Table 5](#), in this study, [Kwakkel et al.'s \(2010\)](#) publication entitled “Adaptive airport strategic planning” become the most cited article.

Overall, the results identify eleven thematic clusters in airport strategic management research and show a clear chronological shift in research emphasis from airport economics and terminal planning toward adaptive planning, decision support, sustainability, stakeholder issues, and responses to changes in the aviation industry. The citation analysis identifies Wijnen as the most prolific author in the dataset and Kwakkel et al.'s “Adaptive airport strategic planning” as the most cited publication.

DISCUSSION

The findings demonstrate that airport strategic management research has evolved from a predominantly economic and infrastructure-oriented perspective toward a broader and more adaptive strategic management agenda. The chronological analysis shows that early studies emphasized airport economics and terminal planning, followed by deregulation and airport system planning, simulation and strategic exploration, adaptive strategic planning and system dynamics, integration with urban and regional development, and, more recently, the dynamics of low-cost carriers and post-pandemic adjustments. This progression is consistent with the historical development described in the literature review, in which airport master planning gradually became less dependent on static forecasts as deregulation, demand volatility, and uncertainty increased the need for more flexible strategic approaches.

The cluster analysis further indicates that airport strategic planning is multidimensional. The eleven clusters encompass capacity prediction, adaptive planning, performance and scenario analysis, stakeholder coordination, decision-support systems, airport-city and spatial development, deregulation, strategic exploration, and responses to low-cost carrier growth. These themes reinforce previous studies discussed in this article. For example, [Wijnen et al. \(2008\)](#) and [Stamatopoulos et al. \(2004\)](#) emphasized decision support for airport strategic planning, while [Kwakkel et al. \(2010\)](#) advanced adaptive airport strategic planning as an approach for dealing with uncertainty. The prominence of [Kwakkel et al. \(2010\)](#) in the citation analysis, where “Adaptive airport strategic planning” is the most cited publication in the dataset, also supports the importance of adaptability and uncertainty management in the development of this research field.

The results also show that airport strategic management increasingly extends beyond the physical airport system. The emergence of sustainability, urban development, airport-city concepts, stakeholder relationships, and regional development indicates a shift toward viewing airports as interconnected components of wider economic, social, and spatial systems. This finding is aligned with [Freestone and Baker \(2011\)](#), who discussed airport-driven urban development, and with the literature reviewed in this study

concerning the integration of airport planning with cities, metropolitan areas, and regional development. At the managerial level, these developments imply that airport operators need strategic planning processes that can accommodate infrastructure capacity, operational performance, stakeholder interests, environmental considerations, market changes, and uncertainty simultaneously.

The publication and citation patterns also provide insight into the intellectual development of the field. Wijnen is identified as the author with the highest number of publications in the dataset, while the most cited studies are concentrated on adaptive planning, system dynamics, airport performance, decision support, capacity management, and airport-led urban development. This pattern suggests that studies offering frameworks and analytical tools for decision-making under uncertainty have had a particularly important role in shaping airport strategic management research.

This study has several limitations. First, the analysis is based on publications retrieved from Google Scholar and Crossref, and the findings therefore reflect the coverage and metadata available from these sources. Second, the study examines publications from 1947 to 2022, so developments after 2022 are outside the scope of the analysis. Third, the content analysis and bibliometric mapping identify relationships among keywords, publications, authors, and citations, but they do not directly evaluate how the identified strategic management approaches perform when implemented by airport operators. Future research can extend the publication period, compare results across additional academic databases, and combine bibliometric analysis with systematic reviews or empirical studies of airport strategic planning practices. Further studies can also examine emerging themes related to post-pandemic airport management, sustainability, adaptive planning, stakeholder coordination, and the continuing evolution of the aviation industry.

CONCLUSION

This study analyzed publications and scientific articles related to airport strategic management over a period of 75 years from 1947 to 2022. The evolution of airport strategic management and the trend of research paradigm regarding airport strategic management could also be identified through this study.

At the beginning, airport strategic management studies focused on economic factors that influenced the determined assumptions in airport strategic management. Then, the studies developed into strategic planning on determining how the airport terminal should be. Airport strategic management studies then evolved with the aviation sector deregulation. Deregulation became a key factor that brought changes to airport management and airline business which in turn had a major impact on the process of formulating airport strategic management.

The airport management began to explore the possibilities of a valid airport management model, especially those that were related to its strategic planning. The airport strategic planning studies then evolved by adopting the system dynamics approach as a tool to determine scenarios and sensitivity analysis in preparing airport strategic management.

In its development, the existence of airports is increasingly integrated with cities, metropolises, regional and even global development. Airport strategic planning studies began to develop the concept of airport city, spatial development, and airport sustainability.

Furthermore, airport strategic management studies focus on the response needed by airport managers in dealing with the growth of low-cost carriers that occurred in the aviation industry. During the last period, airport strategic management studies frequently discuss concepts or keywords related to adjusting physical capital, which experienced quite large adjustments, especially in airport and aircraft infrastructure because the supply chain might become more local than global after the pandemic. The Covid-19 pandemic changed the nature of globalization in the post-pandemic world. In this study, [Wijnen \(2008\)](#) from Delft University of Technology, Faculty of Aerospace Engineering, Delft, The Netherlands become the author with the most published articles. Based on the table above, in this study, [Kwakkel et al.'s \(2010\)](#) publication entitled "Adaptive Airport Strategic Planning" become the most cited article.

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