AIRPORT DESIGN AND DEVELOPMENT

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Contents

Summary

An airport should be developed when benefits surpass disadvantages: Airport advantages are mainly improvements in surrounding economic conditions, and the airport should be designed and constructed to minimize the disadvantages. A notorious negative impact of airports is noise. So, new airports are often constructed far from city

centers to minimize noise issues. However, then airport location creates access problems. So, reasonable compromises are necessary to reduce noise impact while maintaining accessibility.

Airport design should support airport functions, which include aircraft landing, unloading and loading payload and crew, servicing, and takeoff. Therefore, airport design should take into account aircraft landing and takeoff, surface transport access, and passenger and cargo handling, for successful modal transfer. In addition, airports are designed to safety and security standards for aircraft operation and passenger and cargo handling.

Airport development and construction are very large and capital intensive projects that require much advance planning, with serious consideration for growth in air transport demand, availability of required capital, national transport system integrity, and environmental protection.
The primary users of an airport are airlines and air passengers. The airlines maximize profits by minimizing their costs of airport operations. So, the airlines expect airports to be designed to ensure their own airport operational efficiency. Runway, taxiway, and terminal building configuration should support airline operational efficiency. However, safety standards should inform the dimensions, configurations, and locations of landing facilities, and aircraft operational procedures should comply with safety standards established by International Civil Aviation Organization (ICAO) or equivalent national regulations.

Airports should be designed and developed keeping in mind the overall and unique objectives of the individual project, as well as generally accepted common factors. The airport of the future should accommodate new aircraft and air navigation technologies, while simultaneously addressing growing concerns about environmental protection.

1. Introduction

As an essential/integral component of the air transportation system, the airport is the physical site where a transfer is made between air mode and surface mode. It should provide the space, facilities, and services appropriate for that modal transfer. The airport facilities enable aircraft to land, unload and load payload and crew, be serviced, and takeoff. Therefore, airport design should take into account landing and takeoff of aircraft, landside access by surface transport modes, and handling of passengers and cargo, for the successful modal transfer.

Regarding the airport's role as a terminal for passengers, cargo, and airlines, trends in the airline industry need to be considered continuously throughout the airport design and development process. Leading up to the turn of the twenty-first century, as passenger and cargo markets have grown continuously, there have been large changes in route structure, hubbing, deregulation, privatization, computerization, congestion, delay, and so on. Thus, airport designers and planners need to respond flexibly to these changes to provide appropriate services for passengers, cargo, and airlines, while still managing the airport itself profitably. Fife clearly addressed these issues that have

developed from these evolved changes in the airline industry, and their implications for airport design and development.

Airport design has traditionally been mainly concerned with the issues of safety and security related to aircraft operation and passenger and cargo handling. However, the twin issues of operational efficiency and environmental protection have gradually become equally important factors. Presented in this paper are the design concepts and practices necessary for aviation safety and security, operational efficiency, and environmental protection, and furthermore some suggestions for new design concepts under the changing trends in the airline industry. Since various airport design criteria, such as the lengths, widths, angles, gradients, separations and other features of aircraft operations area, vary greatly according to aircraft performance, pilot technique, and weather conditions, both the International Civil Aviation Organization (ICAO) and the United States Federal Aviation Administration (FAA) publish airport design guidelines for various airport classifications. Such standards can assist airport designers and provide a reasonable amount of uniformity in the design of airport facilities, although revision of these guidelines is necessary at the turn of the twenty-first century.

Airport development and construction are very large and capital-intensive projects. However, in recent years, governments have been forced to devote enormous economic resources to build new airports or expand existing airports in order to keep pace with growing passenger and cargo demand. Airport development should be planned far in advance, with serious consideration given to the rate of growth in air transport demand, the availability of required capital, the integrity of the national transport system and the degree of environmental protection. This paper attempts to explore balanced and feasible ways to develop airports.

2. Planning for Airport Development

Airport planning can be divided into two categories; airport system planning and individual airport planning. Airport system planning deals with the interaction between airports, as well as the planning of airports at a regional or national level. Such planning is required for national or statewide funding schedules that support airport development and for ensuring a systematic approach to the allocation of funding among the many eligible airports. It also covers the management of multiple airports in a large metropolitan region.

As for the second category, comprehensive planning for the development of a specific airport is usually included in an airport master plan. Such a master plan is a list of comprehensive concepts for long-term development of an existing airport or construction of a new airport and presents the complete development concepts, utilizing graphical representation where appropriate, and the data and rationale upon which the plan is based. The basic common objectives are:

(a) Developing and presenting the physical facilities of the airport, airspace infrastructure, and vicinity land uses, at present and in the future.
(b) Estimating the environmental effects of facility construction and operation.

(c) Forecasting future air transportation demands to determine the required capacity for each facility at each time phase.
(d) Scheduling of developmental phases in the plan, and planning financial support for the implementation plan.
(e) Evaluating costs and benefits and economic gain of various alternative airport development concepts.

3. Financing Airport Projects

When an airport seeks to expand its facilities or a governmental entity seeks to build a new airport, enormous capital needs to be raised from public fund sources or private capital markets to finance such infrastructure development. Capital sources include government loans and equity, international organizations, commercial capital markets, and credit from contractors and suppliers. Commonly, some amount of governmental investment acts as "seed money" to initiate airport development projects and private sector financing follows. Commercial loans are usually minimized because they incur higher interest rates than governmental or public sector funds, so such commercial capital is only used to finance airport development projects when there is a shortage of public sector funds. The trend toward airport privatization has been initiated to ease the access to private money markets.

When an airport attempts development through private financing, it is common in the US for the local authority to issue revenue bonds. This guarantees debt payment by airport revenue. Sometimes the raising of excessive loans from private sources can lead to debt payment problems for the local authority and residents, as occurred with the New Denver Airport project in the mid-1990s. Therefore, such capital sources have to be balanced with direct and indirect financing of equity and loans.

4. Economic Impacts and Economics of Airport Development

Since transport demand is a derived demand, user benefits are demonstrated self-evidently by the revealed demand. However, the costs to provide all the required services should be carefully considered and compared with their economic benefits. The most salient benefits of airport development are those derived from local employment and the stimulation of the regional economy. A major commercial airport contributes 40 000–50 000 jobs to the local economy, and the presence of a convenient airport is instrumental in companies' decisions to locate in the region. The most notorious disadvantages of airport development and operation are noise and other environmental impacts. To mitigate the problems associated with environmental impacts, substantial capital resources are frequently required.

A large one-time investment is required to develop a commercial airport, and its ongoing operation can generate quite considerable continuous annual revenue. So, part of airport planning is to determine if the development of the airport will be profitable, which entails detailed analysis of the costs and revenues resulting from airport operation. It is generally recognized that large commercial airports with high utilization rates can be operated as successful businesses. Their revenues can cover their full costs,

including capital charges. However, some small and medium sized airports cannot generate enough profit to cover full costs including capital costs.

5. Impact of Aircraft Characteristics on Airport Design

5.1. Design Concepts Related to Aircraft Operations

Advances in aircraft technology have led to improvements in the system performance of air transportation. Technological advances in speed, range, and operating systems have greatly contributed to the high growth rate of the industry. As a major component in an air transportation system, an airport should accommodate future changes in aircraft design and performance associated with overall improvements of system performance. Airlines expect to operate any type of aircraft with low direct operating costs to serve market needs properly. Consequently, while airlines choose which type of aircraft to operate with a view to maximizing their economic efficiency, the airport needs to provide landing fields for airlines while maximizing operational safety and efficiency. Furthermore, gradually increasing concerns for environmental factors are influencing airport design, partly through influence on aircraft technology.

First, runway lengths continually increased until the 1960s to accommodate faster and larger aircraft. Then, improvements in engine techniques (like turbofan aircraft) led to stabilization and even decrease in runway lengths in the 1980s and 1990s. Until the 1960s, airlines had selected aircraft with the sole consideration of economic efficiency through low operating costs. Since then, however, noise problems surrounding airports have forced airlines to compromise between costs and aircraft noise levels. Generally, long-range aircraft require longer runways for takeoff and landing than medium- and short-range aircraft. The required length for each aircraft type is determined by the aircraft's design capability and the safety regulations.

The required strength of the landing field is determined by the weights of operated aircrafts such as absolute weight, weight per wheel, pressure per wheel, and frequency of operation. The distribution of the weight between the main gears and the nose gear varies according to aircraft type and its center of gravity. Aircraft manufacturers publish a variety of data on the weight of each aircraft type, such as maximum landing weight, operating empty weight, zero fuel weight, etc.

Aircraft dimensions, defined by the wingspan and fuselage length, influence the size of the aircraft movement area and the configuration of the terminal building. The length of the fuselage is the factor that determines queuing distances and the spacing of pretakeoff waiting areas. The minimum radius swept by the extremity of the aircraft determines the size of apron and parking space. It is important to understand the aircraft's geometry of movement. The largest radius is the critical factor with respect to clearance to buildings or adjacent aircraft. The width of taxiways is influenced by the track width between the wheels, and the spacing of taxiways is determined mainly by the wingspan.

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Biographical Sketches

Professor **Yeong Heok Lee** received his PhD in Economics from Pennsylvania State University in 1988. Since 1988, he has been active in conducting research on transportation, logistics, and airport investment issues in Korea and participated in developing major air transport policy. From 1993 to 1995, Dr. Lee was the director of air transport research division of the Korea Transport Institute. He has been Professor of Air Transportation, Logistics, and Multi-modal Transport at Hankuk Aviation University in Korea since 1995.

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Professor Chang-Ho Park received his BS from Seoul National University in 1970, his MS in transportation engineering in 1971 from the University of California at Berkeley, and his PhD from the University of Texas at Austin. Since 197, he has been active in both airport-related education and research at Seoul National University. In 2002, he was honored by the President of the Republic of Korea with the Presidential Award for his contribution to the newly opened Incheon International Airport.