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Functional relationship between the runway system and apron/gate area under different demand characteristics

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Abstract

Overall airport airside capacity is commonly identified with the runway system capacity. In this paper, it is observed through the runway system and apron/gate area, assuming that the taxiway system does not impose the capacity constraint. The main issue addressed in this paper is whether overall airside capacity can be determined by comparing the runway system capacity to apron capacity directly one to another or their functional relationship has to be understood and taken into account?

Simple transformation from operations/h into aircraft/h considering the share of arrivals and departures in peak periods may not be sufficient to capture the connection between apron/gate and runway capacities for different airport types. Runway-apron relationship can also depend on demand characteristics e.g. dominant market segments (e.g. scheduled, charter, low-cost, general aviation, cargo), or specific traffic patterns (hubbing or point-to-point services, seasonality in demand, etc.).

This paper primarily focuses on two airport types, with respect to their role in air transport network: origin-destination airports, serving primarily point-to-point traffic, resulting in traffic distribution throughout the day with more or less pronounced peak periods; and hub airports, serving temporally coordinated flights concentrated in waves of flights (solely, or in combination with other point-to-point flights). In the latter case, two different strategies for aircraft stands/gates assignment are observed: exclusive and preferential.

Referring to earlier findings related to apron capacity analysis, the paper summarizes various factors that can affect apron capacity at O/D and hub airports. Simple academic examples are used to show when the capacities of the runway system and apron/gate area can be determined independently of each other, and under which demand characteristics runway-apron relationship should be taken into consideration in the process of airside capacity analysis.

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1. Introduction

As a reflection of what occurs in the case of major airports worldwide, the runway system is considered to be the main airside capacity constraint, and airside capacity is usually expressed through the runway system capacity. It is reasonable, considering that a new runway is a major infrastructural project, both in terms of investment, and in terms of capacity gain.

At major airports, fully developed taxiway systems and large apron/gate areas, with a great number of contact stands and additional remote stands, mainly operate with spared capacity. But yet, maintaining efficient operations between two successive runway capacity expansions is not possible without timely modification or expansion of other airside elements, when (if) it is necessary to respond to expected changes in demand characteristics.

Furthermore, the air transport network counts dozens of major airports while, at the same time, there are hundreds or even thousands of medium and small airports that suffer from different capacity issues. Their main and only concern, until the runway system capacity is reached (if ever), is to expand/modify terminal building, apron area and taxiway system to meet demand requirements.

The paper does not identify airport airside with the runway system, but it observes it through the runway system (hereinafter: runway) and apron/gate complex (hereinafter: apron). It is assumed that the taxiway system has reached mature phase in its development, and it does not present the capacity constraint. The main issue addressed in this paper is whether overall airside capacity can be determined by comparing runway capacity and apron capacity directly one to another or their relationship has to be taken into account?

Services provided to aircraft on the runway and on the apron(s) are different in nature. The runway is entry/exit point to/from the airside system, where service times are the order of magnitude of a few minutes. At apron(s) aircraft are turned-around which requires service times from 20min to as much as several hours (depending on the aircraft class and type of service). Interaction between arrivals and departures exists at both airside elements, but different flows of arrivals and departures interact at these two, due to difference in service times and the transitional (taxi) times between them. This paper does not address physical runway-apron relationship, i.e. an impact of taxi times on exchange of arrivals and departures between the runway and the apron, but it analyzes their functional relationship, related to specific demand characteristics.

Analytical models deliver apron capacity in aircraft/h, while runway capacity is expressed in operations/h. The most common relation is to multiply aircraft/h by two to obtain corresponding operation/h, assuming that one aircraft is related to two operations – arrival and departure. Such a calculation is used, for example, in the FAA's graphical method (FAA 1983). De Neufville and Odoni (2003) suggest taking into consideration largest fraction of arrivals in the traffic mix during a certain time interval, instead of applying default 50/50% share of arrivals and departures.

However, such transformation might not be sufficient to capture the connection between apron and runway capacities for different airport types. Their relationship may depend on demand characteristics e.g. dominant market segments (e.g. scheduled, charter, low-cost, general aviation, cargo), and specific traffic patterns (hubbing or point-to-point services, seasonality in demand, etc.). This paper primarily focuses on two airport types, with respect to their role in air transport network: origin-destination (O/D) airports, serving primarily point-to-point[†] (P2P) traffic (resulting in traffic distribution throughout the day, with more or less pronounced peak periods) and hub airports serving temporally coordinated[‡] flights concentrated in waves of flights (solely, or in combination with other, non-coordinated, P2P flights).

The paper brings up the issue of available capacity under different traffic natures and the necessity to balance between runway and apron capacities in accordance to that. Due to various reasons, airports can be exposed to

[†] The term "point-to-point" flight/traffic hereinafter referrers to non-coordinated aircraft carrying origin-destination passengers rather than transfer passengers.

[‡] The term "coordinated" aircraft/flight/traffic hereinafter refers to aircrfat carrying primarily transfer passengers. Coordinated aircraft are concentrated in waves, aimed at providing efficient transfers between flights.