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# Network performance and competitive impact of the single hub — A case study on Turkish Airlines and Emirates

Michail Logothetis[*], Chikage Miyoshi

*Centre for Air Transport Management, School of Aerospace, Transport and Manufacturing, Martell House, College Road, Cranfield, Bedford, England MK430TR, United Kingdom*

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ABSTRACT

This paper introduces a new model for evaluating connectivity at hub airports. The Hub Connectivity Performance Analyser (HCPA), developed in this context, assesses both schedule- and comfort-related attributes of indirect flights and consolidates the results into two indexes: the Hub Connectivity Performance Index (HCPI) and the Hub Efficiency Index ($\varphi$). The proposed methodology is used to derive conclusions about the hub performance and efficiency of two modern influential super-connectors: Turkish Airlines and Emirates. Connectivity at Istanbul Atatürk and Dubai International airports is therefore evaluated for the said carriers and their alliance code-sharing partners. Historical growth and key O&D flows targeted by each carrier are identified and benchmarked to establish the competitive impact of their hubs. Findings indicate that Emirates operates an ultra-efficient hub, which has superior performance to that of Turkish Airlines; however, in a market-breakdown basis, the dominance is split between the two carriers. Given that both Istanbul Atatürk and Dubai International operate near capacity, the study concludes that the way forward for both carriers is either to opt for up-gauging their fleet or targeting higher hub efficiency.

## 1. Introduction

This paper aims to analyse the network strategy of two emerging airlines, Turkish Airlines (TK) and Emirates (EK), in terms of network connectivity at each hub airport.

The aviation industry has witnessed many changes in recent years. The emergence of low-cost airlines corroded the local point-to-point operations of traditional flag airlines and the rise of the ‘big three’ Gulf carriers, Emirates, Qatar Airways and Etihad, attacked their network and transfer traffic on a global scale. In addition, the transformation of Turkish Airlines into another strong inter-continental connector, building upon Istanbul's excellent geographic location, concluded this significant shift of power away from the now suffering legacy carriers. The secret of success, if any, for these new ‘global connectors’ lies in the heart of their network model: their large hubs. Thus, an analysis focusing on the factors that influence hub efficiency and the evaluation of hub connectivity for such carriers is deemed worthwhile.

The approach followed herein utilises a case study, centred on two of today's most influential mega-hub airlines, Turkish Airlines and Emirates. Turkish has grown rapidly during the last decade, following Turkey's resurgence. Soon after it ceased being a traditional state-run carrier, Turkish adopted the ‘super-connector’ operating model, entering into direct competition with the strong Gulf carriers. Similarly, the growth of Emirates has been notably fast-paced since its establishment in 1985, becoming the world's largest airline as measured by international passenger-kilometres flown; therefore, Emirates and its mega-hub in Dubai constitute a very interesting case for further study.

An analytical tool, the Hub Connectivity Performance Analyser (HCPA), developed in this context, performs the evaluation of hub connectivity. The analyser scrutinises the published schedules of the chosen airlines and evaluates the quality of all viable connections through their hubs. A connectivity model to assess both schedule- and comfort-related attributes of one-stop services is presented, building upon our previous study (Li et al., 2012). Finally, the paper aims to summarise the results; the Hub Connectivity Performance Index (HCPI) and the Hub Efficiency Index ($\varphi$) are proposed, facilitating the positioning of the two carriers (Turkish Airlines and Emirates) on the competition map.

All published schedules were sourced from the Official Airline

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[*] Corresponding author.
*E-mail address:* c.miyoshi@cranfield.ac.uk (M. Logothetis).

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Guide (OAG) for the first week of July of each studied year in 2007, 2008, 2014 and 2016. Seasonality of available airline capacity (ASKs) during an annual cycle shows that airlines tend to deploy more capacity in their summer schedules (March to October). As a result, choosing to analyse data for the first week of July will add significance to the findings, since this is expected to be a period of increased activity. What is more, Turkish joined Star Alliance in April 2008, forming numerous codeshare agreements with its new alliance partners. Therefore, selecting 2007 as the base year, when Turkish had not yet joined Star, will reveal the true gain contributed by its partners when compared to a most recent snapshot. Emirates became the first carrier to serve six continents non-stop from a single hub in October 2007 when it launched services to South America. Thus, it is interesting to examine how its network connectivity developed from the following year (2008) onwards. Base year findings are then benchmarked with a 2014 snapshot; as an update, figures produced based on 2016 schedule data are also provided for the purpose of reinforcing the conclusions.

The paper is structured as follows: previous research in the field of connectivity and various approaches for measuring hub connectivity are presented in section 2. In section 3, the model proposed in this paper is introduced and its specifics are explained. Then, as a case study, connectivity analysis results for the Istanbul and Dubai hubs are presented and benchmarked, while key O&D flows for each carrier are also identified in section 4. Finally, key findings are summarised and conclusions are drawn.

## 2. Hub airport connectivity

A number of different models have already been proposed in previous studies for the assessment of hub connectivity. Hub connectivity refers to the quantity and quality of indirect flights available to passengers via an airline hub (Bootsma, 1997). Consequently, in a hub connectivity analysis, the researcher has to identify the parameters that affect both quantity and quality of connections. Doganis and Dennis (1989) with their 'Hub Potential' and 'Connectivity' models provided the foundation while Veldhuis (1997) and the 'Netscan' model contributed largely to this field. A more recent approach involves the development of optimised connection builders as integrated modules that support airline scheduling based on passenger estimations (Grosche, 2009).

The hub connectivity analysis requires the calculation of the total number of connections ('hits') that can be attained between banks of arriving and departing flights in a hub. Key parameters, essential for the calculation of hub connectivity are Minimum Connecting Time (MCT), Maximum Connecting Time (MACT) and Maximum Geographical Detour (MGD). MCT is the shortest time required to transfer passengers and baggage from the arriving to the departing flight (Seredyński et al., 2014) and depends on both airport-specific parameters and connection type. Airports usually compile and publish monthly updates on the applicable MCTs for all types of connections; however such rules can be very complex for major airports, including hundreds of exceptions. This is why most studies tend to follow a fairly generic approach in selecting MCTs, rather than fully implementing airport rules. MACT on the other hand cannot be objectively quantified, being a measure of the maximum time passengers would tolerate waiting at the hub during a stop-over. Despite the fact that MACT is subjective for each passenger, there are certain factors that influence it. For example, as Veldhuis suggests (Veldhuis, 1997), amenities offered at the hub airport or lower fares may compensate for longer transfer times. In addition, passenger perception of time varies, with transfer-time being perceived longer than time spent on the air (Lijesen, 2004).

One group of researchers adopt fixed values for MCTs and MACTs (see Doganis and Dennis, 1989; Bootsma, 1997; Veldhuis, 1997; Burghouwt and de Wit, 2005; Danesi, 2006; Budde et al., 2008), while others simply qualify connections without applying such limits (see Bania et al., 1998; Dennis, 1998; Malighetti et al., 2008). Table 1 summarises the different practices that various researchers have followed.

Suau-Sanchez and Burghouwt (2012) have followed the same approach proposed by Veldhuis, but they adopted an explicit and higher MACT of 760 min. Another study introduces the 'maximum connection lag' as a key variable that incorporates the effect of both the connection time and the geographical detour (Seredyński et al., 2014); this approach favours connections with shorter detours by allowing longer connection times. Most methodologies utilise routing factors and thus exclude connections involving significant back-tracking (Burghouwt and de Wit, 2005; Danesi, 2006; Malighetti et al., 2008). Veldhuis (1997) developed the 'Netscan' which follows a different course; instead of constraining the routing factor, the model penalises connections involving high detours by attaching to them lower quality indexes. Several studies that adopt the shortest/quickest path methodology limit excessive routing factors by definition (see Shaw, 1993; Shaw and Ivy, 1994; Malighetti et al., 2008). Typical values for route factors proposed and used in past literature are listed in Table 1.

After all viable connections have been identified, connection quality can be evaluated as an important element of the level of service provided by any airline. In this process, various factors (including comfort-related ones) are assessed and consolidated into a single connection-specific quality index. This index is introduced to capture the market appeal of that connection, or in other words, how its value proposition compares to that of a potential direct flight between the same O&D pair. There are three different approaches in evaluating connection quality with the simplest of all being the binary one: the connection is deemed feasible if it meets transfer time and detour thresholds (for example see Dennis, 1994a, 1994b; Budde et al., 2008; Malighetti et al., 2008). In a more detailed level, discrete approaches classify connections according to a qualitative attribute, such as 'poor', 'good' and 'excellent' (see Bootsma, 1997; Danesi, 2006). Finally, the 'Netscan' model (Veldhuis, 1997) and subsequent studies based on it (see Veldhuis and Kroes, 2002; Burghouwt and de Wit, 2005; Burghouwt, 2007; Matsumoto et al., 2008) implement the continuous quality index. This approach attempts to quantify various parameters that affect the market appeal of one-stop operations and is likely to lead to more robust conclusions. Such parameters include but are not limited to the following: transfer time, availability of direct services from competitors, arrival/departure hours, value/frequency of connections, airport facilities and equipment type (Goedeking, 2010; Li et al., 2012). Most researchers incorporate the values of routing, time and competition factors into a single quality index, which is then attached to each feasible connection; for example, van Dalen (van Dalen, 2011) built upon our previous model (Li et al., 2012) by introducing a competition factor. Thus, each indirect connection gains or loses market appeal according to the number of direct seats supplied by competitors: the more direct seats supplied, the less favourable an indirect connection between the same O&D pair becomes.

## 3. Methodology for the Hub Connectivity Performance Analyser (HCPA)

The Hub Connectivity Performance Analyser (HCPA) is proposed as a tool to evaluate connectivity performance and comprises two separate modules: the quantity module and the quality module, developed based on the methodology presented in our previous study (Li et al., 2012). Each of these modules contains various submodules that assess different aspects of indirect services. The HCPA

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