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The impact of airline alliance terminal co-location on airport operations and terminal development

Cheng-Lung Wu*, Andy Lee[1]

School of Aviation, University of New South Wales, Sydney, Australia

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ABSTRACT

The notion of co-locating alliance carriers to their designated terminals in airports has gained significant interest in recent years. While benefits on the part of airlines are made clear by existing literature on alliance-hubbing, the tangible benefits to airport operators are less clear due to a lack of studies in the literature. This paper considers existing cases of London Heathrow, Paris Charles de Gaulle and Tokyo Narita Airport, and applies their operational practices to a medium-sized airport in Asia Pacific to evaluate the universal applicability of alliance member co-location. Although some operational and financial improvements are observed, the paper concludes that implementation of this concept should not be done through a one-size-fits-all approach.

1. Background

The notion of international airlines collaborating for their mutual benefit through the formation of strategic alliances has gained credibility in recent years (Evans, 2001). These strategic alliances, along with a portfolio of co-ordinated synergies, have already impacted on the operations of airport infrastructure worldwide. Being part of a multilateral alliance allows airlines to access markets and resources otherwise not attainable due to current geographical and regulatory constraints (Gudmundsson and Lechner, 2006). To take advantage of each other's network coverage, alliance hubs have emerged at major airports where member airlines' services are heavily concentrated. As a result, the implementation of the concept—alliance terminal co-location—has become a major development in recent alliance strategies, as an airline-side effort to strengthen connectivity and streamline asset utilisation at hub airports. With additional terminal capacity becoming available at many major airports, and as a stable pattern of alliances begins to emerge, airport operators around the world have begun to embrace the concept of alliance terminal co-location and grant member airlines more logical terminal allocations.

Under hub-and-spoke operations, a hub's connectivity is often measured by the number of meaningful connections generated during each schedule wave (Goedeking and Sala, 2004). While shorter connecting times would create a greater number of flight-pairs during each schedule wave without having to extend its duration, a key benefit of airline-dedicated facilities is that they increase the likelihood of intraline connections by making it easier and faster for passengers to transfer to another flight within the same terminal or terminal area (De Barros et al., 2007; Phillips, 1987).

A survey of airlines participating in the alliances showed that the greatest increase in passenger traffic was observed primarily on hub-to-hub routes, and secondarily on hub-to-non-hub routes (Iatrou and Alamdari, 2005). In other words, the provision of seamless connections through hub airports has played an important role in the upsurge of alliance traffic. At many multi-terminal airports, such as London Heathrow Airport, prior to the alliance terminal co-location exercise, the allocation of facilities was made with little effort to minimise the number of inter-terminal transfers required. Instead, sectorisation of services between terminals was determined in such a way that routes serving a similar geographical region used to leave from the same terminal (Hanlon, 1989).

Options towards reducing or removing multi-terminal operations through the expansion of existing or building of new terminals address only the supply-side of the airport congestion problem. To achieve the operational and financial synergies similar to those derived from airline-dedicated terminal facilities in a common-user terminal environment, all three global strategic airline alliances have negotiated, or are in the process of negotiating, alliance terminal co-location at their respective hub airports. This demand-side effort is designed to create synergies in two aspects: one is to improve connectivity and reduce the minimum

* Corresponding author. Tel.: +61 2 9385 4191.
E-mail addresses: c.l.wu@unsw.edu.au (C.-L. Wu), andyjulyau@hotmail.com (A. Lee).
[1] Tel.: +61 2 9385 6637.

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connection time (MCT) at key hub airports; the other is to eliminate replicated station costs by consolidating common processing and brand representation through joint airport equipment and facilities (Wu, 2010).

In a study on the impact of airline hubbing on airline economics in the US, Kanafani and Ghobrial (1985) found that much of the available evidence concerning station costs suggested that average costs per passenger did not necessarily decline with passenger volume at an airport. While it was concluded that the economies of scale of airline hubbing did not apply to station costs, the result may be different in today's alliance hubbing context where station equipment and passenger facilities are more commonly shared than before. Star Alliance has long incorporated the 'Move Under one Roof (MUoR)' concept as a part of its key alliance strategy. The objective of the MUoR concept is to develop exclusive Star Alliance terminals or terminal areas at hub airports to provide customer services (e.g. check-in counters and ticketing office spaces) by utilising member airlines' resources more efficiently (e.g. lounges and ground handling equipment).

By 2010, almost all the world's major network carriers were integrated with, or were being sought by, one of the three multilateral strategic airline alliances (oneworld, SkyTeam and Star Alliance). In a list of established and emerging airport business models proposed by Feldman (2009), the author highlighted the strategy of being "alliance anchor hubs" as a successfully established business model for airports around the world. With both parties having the intention of strengthening the airport's role as an alliance hub, airport operators and airlines need to work together to ensure that their facilities and services are capable of adapting to today's competitive and economic environment. While Feldman considered that the business model of being an 'alliance anchor hub' is more relevant to airports that can attract high volume of passengers each year, he did not acknowledge that the context of alliance hubbing today is not only limited to co-ordinating network and attracting connecting passengers, but also facilitating the consolidation of back-office functions and sharing of airside resources and operations management for cost reduction.

Hence, this paper aims to better understand why some airport operators have supported the 'alliance terminal co-location' concept—even at locations with low volumes of connecting traffic—apart from identifying the potential operational and financial incentives and implications for airports to implement the strategy. This paper is organised as follows: section two provides a brief description of the methodology used; section three provides a systematic discussion of three example airports that have recently implemented the terminal co-location concept; this is followed by a case study in section four with conclusions provided in section five.

2. Methodology

The underlying reasons motivating airport operators to implement the concept of alliance terminal co-location are varied and complex. Some are directly related to the strategic development of global airline alliances, while others are concerned with the operational characteristics and financial structure of the airport operators themselves. To explore the rationale of the implementation of alliance terminal co-location at airports worldwide, we analyse three sample airports that had gone through terminal co-location exercises in the past few years, including London Heathrow Airport, Paris Charles de Gaulle Airport and Tokyo Narita Airport. These airports were selected based on the following criteria: 1) a network hub for at least two of the three major airline alliances (i.e. oneworld, SkyTeam and Star Alliance) and 2) with alliance terminal co-location already implemented.

A series of interviews with airport authorities were conducted both face-to-face and by email correspondence. Prior to contacting the airport operators of the above sample airports, secondary data concerning each airport's airline activities, alliance initiatives, operational statistics as well as financial characteristics were gathered to formulate an understanding of how each sample airport exercised the concept of alliance terminal co-location in its unique business environment. Once contact with each sample airport was established and the intentions of the case analysis were communicated, an interview was arranged to collect primary data at each sample airport. Moreover, the meeting presented a unique opportunity to observe and document the specific airline/airport constraints or merits experienced at each sample airport as a result of implementing the concept, which could later be tested on the case study airport.

To evaluate the universal applicability of findings from the qualitative study of sample airports, they are applied to a medium-sized Asia—Pacific airport as a case study. In particular, we focus on the allocation of check-in counters and aircraft parking bays at the case airport's international terminal. A typical week schedule of the Northern Summer 2011 (NS11) season is applied in this study as the 'Base Case' to reflect the real-life passenger and aircraft demands at this terminal. For the purpose of assessing the operational and financial impact of the alliance-driven common check-in concept at the case airport, a proposed scenario is assessed against the base case. In this scenario, alliance-driven common allocations are applied to airlines of oneworld, SkyTeam and Star Alliance, while the remaining non-aligned carriers adopt their existing block allocations. Existing terminal resource allocation parameters, e.g. passenger arrival profiles, transaction times and check-in allocation procedures, are applied to both the base case and the proposed scenario.

To analysis the operational impact of the alliance-driven terminal aircraft parking bay allocation, the base case is assessed against the scenario in which the allocation of terminal aircraft parking positions is prioritised to flights operated by airlines of oneworld, SkyTeam and Star Alliance; flights operated by non-aligned carriers are assigned to the terminal parking positions wherever possible, otherwise to the remote parking positions. Existing apron limitations and allocation procedures are used as a guideline for aircraft parking allocation criteria and priorities. A key indicator used to determine the operational efficiency of the alliance-driven terminal aircraft parking allocation is the number of flights that require passenger bussing operations between the terminal and remote aircraft stands.

3. Existing terminal co-location cases

While the current airline alliance groupings might serve as the backdrop to an airport operator's decision to implement the 'alliance under one roof' concept, airports will only embrace the idea when their internal circumstances make this the correct operational and/or financial move. For the purpose of validating the hypothetical driving forces for airport operators to adopt the strategic arrangement of alliance terminal co-location, three global hub airports—London Heathrow Airport (LHR), Paris Charles de Gaulle Airport (CDG), Tokyo Narita Airport (NRT)—with the concept currently in place are selected as the sample airports for this paper's case analysis.

3.1. London Heathrow Airport (previously managed by BAA Airports Limited — now called Heathrow Airport Holdings)

London Heathrow Airport up until recently had five passenger terminals and a pair of parallel runways. Three terminals (T1—T3) were located at the Central Terminal Area. Due to space constraints at the central terminal site, Terminal 4 (T4) was constructed to the south of the southern runway (Runway 09R/27L) next to the existing Cargo Terminal. When Terminal 5 (T5) was commissioned in 2008, a complex airline terminal re-allocation program was subsequently implemented. This has seen many airlines moved so as to be grouped in terminals based on alliance alignment. As the sole airline occupant of T5, British Airways was able to consolidate its operations—previously spread across T1, T3 and T4—only to T5 and its neighbouring T3. Details of this so-called "Post T5 Musical Chairs" airline terminal re-allocation program will be further discussed in the following sections.

3.1.1. Terminal co-location at London Heathrow Airport

It was estimated that the new T5 would provide Heathrow with an additional passenger handling capacity of up to 35 million passengers per annum (BAA Heathrow, 2005b). To fulfil its long-term strategy of reinforcing its status as a leading international network hub airport, London Heathrow Airport's airline terminal re-allocation plan was drafted under the approach of making the best use of the airport facilities, and satisfying alliance aspirations by co-locating airline alliances in different parts of the airport (BAA Heathrow, 2005a).

Initially, discussions on how to reshuffle Heathrow's airline operators following the completion of T5 Phase I were conducted between the airport operator and its five main alliances/airlines—namely British Airways, oneworld, SkyTeam, Star Alliance and Virgin Atlantic Airways. Preliminary talks with other non-aligned airlines at Heathrow were also held. The keystone of the proposed allocation plan was the assignment of home carrier British Airways to the new T5, in a bid to house the airline's entire operations in one single terminal. However, citing that T5 Phase II would not be completed until spring 2011, the adjacent T3 was chosen to host those BA flights that could not be accommodated at T5. T2 had been intentionally left out of the so-called "Post T5 Musical Chairs" airline terminal relocation program, as the airport operator had previously outlined its proposal to replace the existing T1 and T2 with a single Heathrow East Terminal capable of handling up to 30 million passengers per annum (BAA Heathrow, 2005c).

The first alliance grouping to come to agreement with BAA Heathrow for terminal co-location was the Star Alliance in late 2004. The decision by British Airways to relocate its Heathrow operations at T1 into T5 during the initial phase in 2008 had allowed all Star Alliance members to co-locate at T1 rather than the alliance's original plan to occupy both T1 and T3. Consequently, this eliminated the need for BAA Heathrow to build a mini terminal between T1 and T3 to support Star Alliance's short-haul operations. However, not all Star Alliance members are currently housed in T1. Singapore Airlines, for instance, remains at T3 as T1 is not capable of handling the airline's Airbus A380 operations.

The member airlines of the oneworld alliance and BAA Heathrow signed their MoU for terminal co-location on 13 March 2006. The alliance, headed by home-based British Airways, at that time accounted for more than 50% of Heathrow's traffic equivalent to approximately 35 million passengers a year (BAA Heathrow, 2006). While T3—the closest of the existing terminals to the new terminal—had previously been negotiated as BA's 'overflow' facility for 30% of its operations before T5 Phase II could be completed, it was therefore chosen as the terminal for other oneworld carriers to co-locate their operations at Heathrow. For BA, vacating T4 meant delays caused by its own aircraft towing to and from the Central Terminal Area (CTA) would be eliminated. With the southern runway (Runway 09R/27L) constantly operating at maximum capacity, runway crossing between T4 and the CTA had been a time-consuming process for the home-based carrier, resulting in an appreciable loss in runway capacity for the airport operator (British Airways, 2008). For oneworld, this effectively reduced the alliance's presence at the airport from four to two terminals.

The last alliance grouping to come to agreement with BAA Heathrow was SkyTeam. On 12 June 2006, the two parties agreed in their MoU to eventually co-locate the SkyTeam operators at Heathrow's T4. While SkyTeam at that time carried the least passengers at Heathrow Airport among the three major airline alliances, the spare capacity at T4 was therefore designated to host Heathrow's non-alliance aligned airlines. However, T4's occupancy strategy, after T5 opened in 2008, could not be achieved without the extensive refurbishment performed on T4's passenger processing facilities such as check-in counters, departure lounges and baggage reclaims. Prior to BA vacating the terminal in 2008, the airline's operations (predominately long haul) accounted for 82% of the total passengers in T4, with around 40% of those passengers transferred by aircraft at Heathrow. While these transfer passengers did not require accessing the check-in and reclaim facilities in T4, it was anticipated that the new terminal occupancy strategy involving SkyTeam carriers and other non-aligned airlines would lower the number of transfer passengers, and subsequently lead to a higher demand for passenger processing facilities related to O&D passengers in T4.

The postponement of BA long-haul flights vacating T4 resulted in a knock-on impact on many other airlines at Heathrow, whose own moves between terminals depended on BA vacating its old premises (Alloway, 2008; Broadbent, 2008a). The delay of BA's second stage move to T5, and the planned closure of T2 in preparation for the Heathrow East Terminal project led to BAA Heathrow undertaking a major reconfiguration of airlines' disrupted terminal relocation schedules. Airlines such as Lufthansa faced up to 12-month delay under the revised schedules. Shortly after the postponement was confirmed, Lufthansa informed BAA Heathrow that it would seek compensation from the airport operator of £200,000 for each month the airline was to be delayed (Broadbent, 2008b). While it remains unclear whether the German airline was financially compensated by BAA Heathrow in the end, this example demonstrated the challenges and risks that an airport operator—such as BAA Heathrow in this instance—could be exposed to during the implementation of alliance terminal co-location.

3.2. Paris Charles de Gaulle Airport (managed by Aéroports de Paris, ADP)

Paris Charles de Gaulle Airport has two terminals and four runways. The airport currently serves as the principal hub for home-based carrier Air France and is a European hub for Air France's SkyTeam partner Delta Air Lines. In 2009, connecting passengers represented 32% of the total passenger traffic at Paris Charles de Gaulle Airport, compared to 50% of Air France's overall passenger traffic at the airport.

With the rapid expansion of T2, from the initial two to today's seven sub terminals, designations of Schengen and non-Schengen traffic to various sections of the terminal have subsequently evolved. The latest example involves the conversion of T2F (currently shared among the two traffic modes) to a full Schengen terminal area following the completion of T2E Satellite 4 (which will be dedicated to long-haul non-Schengen traffic). Other than creating new aircraft and passenger handling capacities, facility modernisation is another key focus for ADP. Renovation works for the ageing T1 commenced in 2004 to align its level of service with the newer T2. Reconstruction of the central terminal area was completed in 2009 which brought T1's handling capacity to 11 million passengers per year (Aéroports de Paris, 2009).

In addition to passenger and aircraft handling facilities, one of the most important developments to Charles de Gaulle Airport's accessibility was the agreement signed between ADP and SNCF-French National Railway in 1990 to construct a high-speed TGV railway station at T2. Today, Charles de Gaulle Airport leads intermodal transport between aircraft and train. Many airlines have formed code-share relationship with SNCF-French National Railway in recent years to gain access to the French domestic and north-western European regional markets which have long been dominated by Air France and other French carriers.

3.2.1. Terminal co-location at Paris Charles de Gaulle Airport

The current terminal location at which members of the three major airline alliances are co-located at Charles de Gaulle Airport was physically formed during 2005–2009. However, Star Alliance's intention to implement its 'Move Under one Roof (MUoR)' strategy at Paris Charles de Gaulle Airport emerged as early as in 1999. The airport has been characterised by the airline grouping as its largest non-home market airport in the network.

Before Star Alliance first approached ADP to secure a terminal location to centre its member airlines' operations at Charles de Gaulle Airport, its member carriers were distributed primarily in T1 with others across the sub terminals of T2. To take on Air France in its own market, the alliance initially sought to centre the facilities of all its member airlines in T2A. The strategic importance of T2A to Star Alliance's presence at Charles de Gaulle Airport was identified through two main aspects. First, having all members in the same terminal would allow customers travelling on alliance flights to make smooth connections between its airlines and cut down costs associated with operating out of two terminals. Second, T2A would also offer direct rail access to the French provincial and north-western European regional markets. While an independent study was contracted by Star Alliance to demonstrate that such a move was operationally feasible, the alliance's efforts were denied by ADP on the grounds that: 1) T2A did not have the adequate capacity and space to accommodate all its member airlines as well as the 3 million Star Alliance passengers per year and 2) the vast majority of Star Alliance members were already operating from T1. Instead, ADP put forward a proposal to co-locate the airline grouping's operations in T1 following the completion of a €280 million terminal refurbishment and modernisation (Aéroports de Paris, 2009; Barkin, 1999).

The physical terminal relocation of Star Alliance member carriers to T1 was carried out during 2005–2008. By the Northern Summer 2010 (NS10) airline operating season, 20 out of the 22 Star Alliance carriers operating at Paris Charles de Gaulle Airport were co-located at T1, leaving Air Canada and Austrian Airlines as the only exceptions (Aéroports de Paris, 2010). Air Canada preferred to stay at T2A for its superior access to the SNCF railway station as most of its connecting passengers are from the TGV high speed trains instead of Star Alliance partners flights, whereas Austrian Airlines decided to remain at T2D due to its code-share arrangement with Air France between Paris and Vienna. Meanwhile, a Joint Operations Control Centre (JOCC) was also established by Star Alliance to monitor member carriers' airside operations at Charles de Gaulle Airport. The principle objective of this initiative was on operating cost reduction. According to Star Alliance in 2004, the departure delays at Charles de Gaulle Airport were costing the Star Alliance member airlines approximately €9.5 million per annum. This was calculated based on an average departure delay of 11 min per Star Alliance flight at CDG and an estimated departure delay at a cost of €58 per minute (Jerrard, 2004).

In 2006, ADP engaged with Air France in the "Réussir Ensemble" (Succeeding Together) co-operative initiative evolving their partnership beyond day-to-day operational matters to long-term strategic affiliation. Under the framework of this partnership, Air France and its SkyTeam partners were assigned to the newer sub terminals of T2, including T2C, T2D, T2E, T2F and T2G. There is a mutual understanding between ADP and Air France that T2E and T2F are particularly out of bounds to non-SkyTeam carriers unless they have code-share arrangements in place with Air France. While the "Réussir Ensemble" agreement aims to optimise operational processes as much as to harmonise management of projects for infrastructure used by Air France, ADP has contracted out to Air France the allocation of aircraft parking and check-in facilities, particularly at terminals accessed by Air France and its SkyTeam partners (Aéroports de Paris, 2008). Currently, the French carrier facilitates the function of aircraft parking allocation at T2A–T2F and check-in allocation at T2E and T2F.

The last alliance to complete its current terminal co-location was oneworld, with British Airways and Royal Jordanian relocated from T2B to T2A alongside those of their oneworld partners American Airlines and Cathay Pacific in 2009. This leaves Japan Airlines as the only non-Schengen oneworld carrier serving the airport outside of T2A. The Japanese carrier currently operates out of T2E alongside its code-share partner Air France. Similarly, another oneworld member Finnair has been allocated to Air France's Schengen-equipped T2D also due to its code-share arrangement with the home-based carrier.

Although it has been demonstrated that the concept of alliance terminal co-location presents numerous benefits for member airlines ranging from shared ground facilities to enhanced connectivity, the incentives for the French airport operator ADP to implement such an airline-oriented project is yet to be discussed. One of the reasons, reported by O'Toole (2002), for Star Alliance's efforts to secure terminal co-location at Paris Charles de Gaulle Airport's T1 with ADP was a "guarantee that it will bring significant traffic growth to the airport to make maximum use of the terminal space." According to the forecast, the Star Alliance traffic at CDG would increase from approximately 5.5 million passengers in 2000 to 7.5 million by 2005. In reality, ADP passenger figures showed that the Star Alliance carriers only brought 4.7 million passengers to Charles de Gaulle Airport in 2005, which rose slightly to 5.2 million in 2010. The underperformance of Star Alliance's passenger traffic at CDG certainly does not justify the €280 million investments by ADP to modernise T1, which included €107.7 million renovation in accordance to the alliance's specification (Aéroports de Paris, 2006, 2009). However, the airport operator ADP's ownership structure provides a clue to justify the airport operator's co-operative approach in meeting airline alliances' demands.

ADP was originally created as a government-owned corporation in 1945. While it later became a public company (known in France as a société anonyme) on 20 April 2005, the majority of its ownership remained under the French Government. As a semi-government controlled corporation with France's national interests in mind, ADP has placed long-term growth, quality of service and airport–airline relationships at the centre of its strategy. In T1's case, the co-location of Star Alliance members is merely a by-product of ADP's desire to bring the ageing terminal in-line with its current development attributes (long-term growth, quality of service and airport–airline relationships) as outlined above. To maintain the balance of traffic across all terminals, the capacity gain (additional 3.5 million passengers per year) realised from T1's renovation was therefore allocated to meet the outlook of Star Alliance's traffic growth at Charles de Gaulle Airport.

3.3. Tokyo Narita Airport (managed by Narita International Airport Corporation)

Tokyo Narita Airport commenced operations with a single terminal structure (currently known as T1) and a 4000 m runway (Runway

A or 16R/34L). Apart from the addition of a parallel runway (Runway B or 16L/34R) commissioned on 18 April 2002, terminal capacity has also been expanded following the completion of a 12-year redevelopment program at T1 on 2 June 2006. Today, it serves as the main international hub of Japan's flag carrier Japan Airlines (JAL) and All Nippon Airways (ANA), as well as an Asian hub for US based carriers Delta Air Lines and United Airlines. This makes Narita Airport a major connecting point for air traffic between Asia and the Americas.

3.3.1. Terminal co-location at Tokyo Narita Airport

Narita Airport's "Airline Relocation Program" first emerged when the airport operator (NAA; then Narita Airport Authority) communicated its intention of reshuffling airlines across the terminals to the AOC (Airline Operators Committee) on 18 October 2000. To attain the understanding and consensus of key operating carriers (in terms of aircraft movements) prior to the AOC level consultations, NAA had individually approached JAL, ANA, American Airlines, Northwest Airlines and United Airlines regarding their terminal preferences. Moreover, the objective of the latest "Airline Relocation Program" was to maximise utilisation of terminal assets through balancing aircraft and passenger traffic at the two terminals. Since then, while ANA has become the second largest operator at Narita Airport, it was essential to separate the two Japanese carriers (i.e. JAL and ANA) along with their respective ground handling client airlines in different terminals to rectify the imbalance of aircraft and passenger traffic between T1 and T2. Additional considerations around the current airline alliance groupings were also taken into account to improve connections for transfer passengers at Narita Airport.

Since the commencement of T1's reconstruction, T2 has been exposed to a very substantial growth in aircraft, passenger traffic and airline numbers. This has caused a number of operational issues such as:

1. There were 16 and 44 airlines housed in T1 and T2 before the "Airline Relocation Program". Approximately 66% of Narita Airport's aircraft/passenger traffic were processed at T2 at the time before airline relocation, while the remaining were processed at T1.
2. Airlines with similar operating schedules were allocated in the same terminal. This had created excessive peaking of aircraft and passenger traffic, and inefficient use of passenger processing facilities at both terminals.
3. In September 2003, 36% of the passenger flights in T1 and T2 code-shared with other operators at Narita Airport with almost 66% of these flights operated in a different terminal from their code-share partner airlines (Narita International Airport Corporation, 2006).

The airline reshuffle plan was intended to overcome these problems and co-locate alliance member airlines in their respective terminal areas. Our interview with Narita International Airport Corporation (2008) confirmed that the "Airline Relocation Program" was made possible primarily because of the additional aircraft and passenger processing capacities made available through T1's reconstruction. With Star Alliance's ambition to "Move Under one Roof" at all hubs and ANA being the home carrier at Narita Airport, ANA had nominated itself to be relocated to T1 accompanied by most of its Star Alliance partners. The relocation plan was finalised and presented to the AOC on 25 March 2004; both parties agreed in principal that the airline members of SkyTeam, Star Alliance and oneworld would be co-located at T1 North Wing, South Wing and T2, respectively.

Despite airlines, such as Air New Zealand (Star Alliance) and British Airways (oneworld), have declined to be co-located alongside their alliance partners for commercial (Air New Zealand's code-share with JAL) and operational reasons (British Airways' closer to Runway A), this initial implementation of the "Airline Relocation Program" resulted in a 48%–52% aircraft movement split across the two terminals under the Northern Summer 2005 (NS05) schedule. The initial implementation not only resulted in an improvement from the previous 34%–66% split but also became proportional to the number of aircraft parking positions available at each terminal (37 vs. 30 terminal contact positions, or 45%–55% split). This has subsequently improved the percentages of aircraft being assigned to terminal contact positions at both terminals. The check-in counters dedicated to Star Alliance member carriers in T1 South Wing have also been re-arranged in zones according to class of travel. Passengers of participating carriers are able to take advantage of "Zonal Check-in" irrespective of carrier of travel (Star Alliance Services GmbH, 2006). This is primarily made possible as all of these carriers share a common IT platform and are ground-handled by their local Star Alliance partner ANA at the same terminal. This initiative by Star Alliance demonstrated how free check-in capacity can be created by consolidating the check-in processes of alliance carriers in their respective check-in counters/areas.

Apart from the operational improvements demonstrated above, Narita Airport's "Airline Relocation Program" also posed several financial and property merits to both the airport operator and airlines. With alliance partners co-located in their respective terminals, airlines are able to reduce capital investments and running costs on ticketing offices and VIP lounges by sharing these facilities. Consequently, the problem of limited terminal space to accommodate other airline clients and service aspects was alleviated. Retail business has continued to consolidate itself as one of NAA's mainstay operations following the airport's corporatisation in 2004. The company's retail revenue from sales of merchandise, food and beverage sharply increased by 73.8% since a year ago with T1's and T2's expanded duty-free areas completing their first full year of trading since June 2006 and April 2007 (Narita International Airport Corporation, 2008). Between 2006 and 2008, 13 lounges at Narita Airport were either newly opened or renovated. As a result, NAA's facility leasing revenue in 2007/08 rose by 1.4% compared to 2006/07 due to increased leasing area in airline lounges and other rental space.

While the current terminal allocation was concluded based on alliance groupings back at the planning stage, many of these alliance alignments have since changed. For instance, Continental (CO) switched from SkyTeam (at T1 North) to Star Alliance (at T1 South) in October 2009, whereas Vietnam Airlines (VN) at T2 joined SkyTeam in June 2010. While the airport operator (NAA) is well-aware of the prevailing volatility of the airline industry and alliance dynamics, it has facilitated at least six airline terminal changes to accommodate recent alliance realignment since the initial completion of the "Airline Relocation Program".

3.4. Comparison of sample airports

In summary, the implementation of alliance terminal co-location seems to depend on three core factors that are related to the airport operator and their airline customers: (1) Terminal co-location initiatives (i.e. how the plan was developed), (2) Airport traffic, capacity, ownership and service levels (i.e. airport operations) and (3) Alliance terminal co-location synergies and constraints (i.e. alliance co-location demands).

Table 1 below provides a high level comparison of the operational characteristics and ownerships of the sample airports. Regardless of the backgrounds of their alliance terminal co-location projects, the reorganisation of airline terminal allocations at all three sample airports has brought the following new operational practices and financial opportunities and generated both new synergies and constraints. First, the major sources of alliance synergies for member airlines at an airport came from complementary networks, sharing of common ground facilities, handling agents and joint operations control. While all of the above initiatives have been implemented at the sample airports, the realignment of airport facilities, ground handling contracts and flight operations co-ordination have proven to be the most complex but yet most desirable forms of alliance collaboration for both the airlines and the airport operators. For instance, comprehensive collaboration in operations control was practised at both Paris Charles de Gaulle and Tokyo Narita, where the planning aspects of aircraft parking allocation were facilitated by their home carriers or the airline alliances. The airport operators were therefore only responsible for monitoring and co-ordinating aircraft activities on the day of operation.

Second, a number of constraints were experienced at the sample airports including: terminal capacity and functional separations, runway configurations, airline ground handling arrangements and the fluidity of alliance memberships. The most common issue observed at the sample airports was the collaboration among alliance partners being overshadowed by individual member airlines' existing code-share/commercial agreements with other carriers outside of own alliances and individual commercial arrangements in ground handling contracts. Bounded by these ad-hoc airline preferences, the full extent of alliance terminal co-location could not be realised. This was further complicated by the fluidity of alliance memberships. For instance, the largest airline customer of Narita Airport, JAL, at one stage was contemplating switching from oneworld to SkyTeam. This prompted the airport operator to reassess the potential effects this could have on its future airline space allocations and terminal capacities, post-Airline Relocation Program at Narita. In addition, the vast presence of alliance branding throughout common-use terminals could restrict airport operators' flexibility to allocate their terminal resources, with non-aligned airlines perceiving the arrangements as unwelcomed "favouritism" and anti-competitive dominance by the airport operators.

4. Case study

To examine if the application of such a concept can potentially improve its operational and financial performance, a medium-sized airport in Asia Pacific was used as a case study representing airports currently with no implementation of alliance terminal co-location. Due to a confidentiality agreement with the case study airport to gain access to sensitive operational and financial data for this project, the true identity of the case airport cannot be disclosed and must remain anonymous.

Table 1
Operational characteristics and ownerships of sample airports in 2010.

Attributes	London Heathrow Airport (LHR)	Paris Charles de Gaulle Airport (CDG)	Tokyo Narita Airport (NRT)
No. of passenger terminals	5	3	2
Latest terminal addition (date)	T5 (2008)	T2G (2009)	T1 South Wing (2006)
Connecting passenger share	35%	30%	18%
Ownership (privatisation date)	Privatised (1987)	Privatised (2005)	Corporatised (2004)
Alliance terminal co-location			
Commencement date	2008	2005	2006
Owner of initiative	Airport operator (BAA)	Airlines (Star Alliance)	Airport operator (NAA)
Check-in co-location	Yes	Yes	Yes
Lounge co-location	Yes	Yes	No
Aircraft parking co-location	Yes	Yes	Yes

4.1. Case study airport

The case airport has three terminals and three runways. While the two domestic terminals are located on the eastern side, its international terminal is located on the western side of the airport. The two terminal precincts are separated by the airport's main runway. As a common-use terminal, the allocation of terminal facilities at the international terminal, such as check-in counters and aircraft parking positions, remains under the planning and co-ordination by the airport operator. Recent observations at the case airport have shown a trend of alliance member airlines concentrating at certain concourses of the international terminal to operate alongside their partners, including activities such as terminal facilities sharing (e.g. lounges). Passenger traffic to and from the airport is predominantly point-to-point, with the international-to-international transfer/transit traffic mainly connecting onwards to neighbouring countries in the region. In 2010, international-to-international transfer/transit passengers accounted for less than 10% of this airport's annual passenger throughput.

A review on the case airport's current operating environment has shown that check-in facilities and terminal aircraft parking positions are the two scarcest passenger and aircraft handling resources at its international terminal. Quantitative tests, based on existing practices of the case airport around these resources, were applied to assess if the implementation of the alliance terminal co-location concept can bring operational and financial merits to these existing bottlenecks in operations.

4.2. Check-in counter allocation

Based on the requests submitted by airlines at the start of each scheduling season, the 192 check-in counters at the international terminal of the case airport are assigned in block or demand-based profiled allocations. The procedure starts by allocating airlines with the most frequent and consistent flight schedules until all the airlines' check-in counter requests have been allocated. Existing allocations over a NS11 typical week (22–28 August 2011) were documented as the base case to: 1) map the current counter demands, 2) identify the busy day(s) of the week and limitations of the current process and 3) provide a benchmark for the proposed changes in subsequent scenario simulations.

The busy day in terms of check-in counter demand took place on Tuesday with a peak demand of 185 positions at 0830 h in the morning, as a result of more concentrated morning departures than the rest of the week. The most comprehensive allocations were noted at check-in islands occupied by the home-based carrier, where the majority of the counters have been assigned from 0400 to 2200 h to process the airline's regular departures, leaving minimal residual capacities at these check-in areas. The overlapped check-in windows and combined passenger arrival profiles can result in a more constant demand of counters over a long period of time, which is not sustainable for a single flight demand (Chun and Mak, 1999). At the case airport's international terminal where check-in counters are scarce during the morning peaks, similar common check-in arrangements could be extended to alliance member airlines to co-locate and consolidate existing flight-driven counter allocations and free up check-in capacities.

Resource simulation of international terminal's check-in counter demands was conducted. Each alliance's counter demands were calculated by applying the same seat factor (100%), passenger arrival profile (bell-shaped normal distribution) and processing rate at check-in (2.5 min/pax) to all alliances' departure flights, whereas non-aligned carriers' block counter demands were documented from each airline's request submitted to the airport operator containing the number of check-in counters required and their opening and closing times for each flight or flight group. Modelling results of a typical busy day (Tuesday) showed the overall (three alliance groupings and non-aligned carriers) check-in demands not only capped under the 192-counter capacity but also lowered from the current levels across the day. Peak demand of the day was reduced from 185 to 171 counters (see Fig. 1). Results of individual alliances' counter requirements also demonstrated resource synergies on their respective busy days (see Fig. 2).

Out of the three alliances, the co-location of SkyTeam carriers presented the most obvious resource savings during the terminal busy hour (0800 h), when the check-in windows of its member carriers traditionally overlapped. While statistical analysis in this scenario demonstrated the merits of alliance common check-in in streamlining overall check-in demands at the international terminal, demand-based profile allocations may cause 'revenue leakage' when moving away from existing block allocation policy. In this proposed scenario, the reduction in counter usage revenue on the typical busy day (Tuesday) equates to more than $12,300 based on the current check-in charge ($21.15 per counter per hour). This is approximately the check-in revenue from 26 additional flights (each with 9 counters in block profile of 2.5 h), which is an amount of traffic that is not easy for an airport operator to attract in a short period of time.

The outcome of the proposed scenario has shown potential benefits for the case airport to introduce alliance common check-in to: 1) relieve its international terminal's check-in capacity shortfalls during the morning peak periods and 2) delay the trigger for large scale capital investments to expand this terminal's check-in facilities. A challenge identified by the alliance's local managers (of member carriers) is to channel initiatives back up the chain to receive head office support and legal guidance. Apart from the reality of ground handling contracts and the need for strong relationships at head office level from the customer airlines' end, the operator of the case airport also faces the justification of foregoing short-term gains from check-in revenue to: 1) allow additional traffic during the morning peak periods and 2) delay capital investments for future check-in expansions. In the proposed scenario, moving the alliance groupings' check-in allocations to a pure demand-driven approach has resulted in a revenue reduction of more than $12,300 on a typical busy day (Tuesday). It is therefore essential for the airport operator to secure additional revenue streams from check-in counter areas through commercial agreements, such as first-right access (i.e. priority block allocation), permanent check-in branding, priority/premium dedicated check-in area and alliance IT proprietary with major airline alliances.

4.3. Aircraft parking allocation

At the case airport, aircraft parking bay allocation of all international operations are facilitated at international terminal aprons, utilising a mix of terminal (contact) and off-terminal (remote) positions. There are currently 25 aircraft parking positions at this terminal—13 at one concourse and 12 at another, providing passengers with direct access between the terminal and aircraft via the aerobridges or ground-level ramp. For a common-use terminal, its pier finger terminal configuration has long been a barrier to allow the airport operator to better assign aircraft parking. The two piers are approximately 450 m apart in walking distance, and each have their own processing halls for transfer/transit passengers and separate premium lounges for specific airlines. Depending on the terminal locations of their lounges, over time airlines have formed preferences to arrive and depart their flights at a specific pier. Apart from pier preferences by individual airlines, the allocation policy of parking that stands at the case airport also takes into account factors such as aircraft types, sizes, airline flight frequency rankings and seasonal adjustments of seat capacity.

During the terminal's busy periods (0600–1000 h), airlines have been competing for access to the terminal aircraft parking positions to avoid passenger bussing operations when their aircraft are assigned to remote parking positions. Another approach adopted by the airport operator to overcome the capacity shortfall of its international terminal's parking positions is to reposition aircraft with turnaround times longer than 180 min to off-terminal parking positions during their layover periods. This includes utilising the home-based carrier's maintenance area for layover parking of the airline's aircraft. However, aircraft towing operations have proven challenging during the morning peak, when the terminal's aprons are already congested with taxiing and pushback aircraft. Moreover, runway crossing is regularly held back by take-off and landing aircraft traffic.

The base case results showed Saturday as the busy day in terms of aircraft parking demand with a total of 173 scheduled aircraft movements (including arrivals and departures) at the international terminal throughout the day. Overall aircraft parking allocations for the day involved two irregular assignments (departures with bussing operations). In addition, 45 aircraft towing activities were recorded as a result of: 1) morning arrivals scheduled to layover until the afternoon turnarounds to cover time differences between

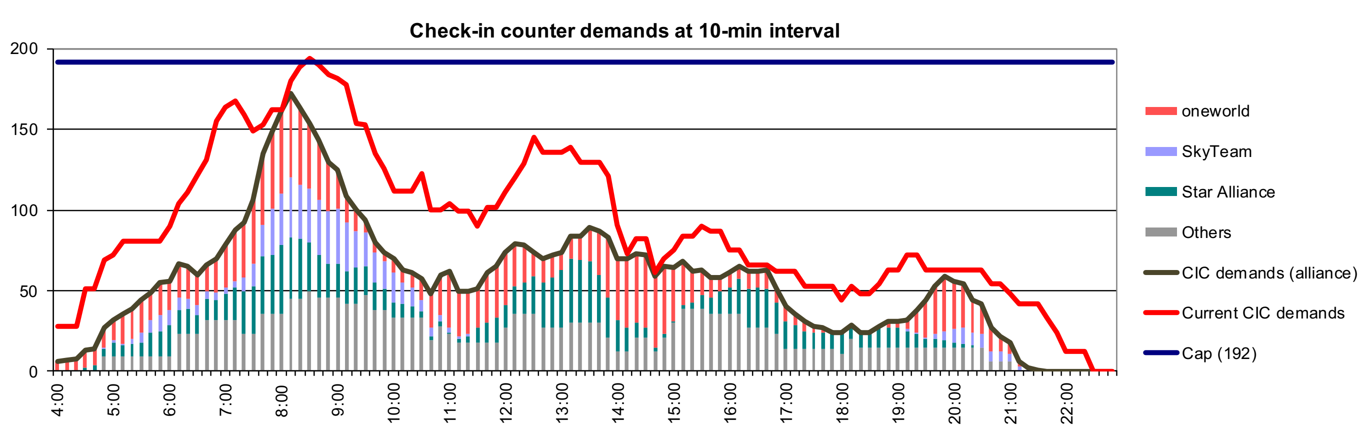

Fig. 1. International terminal check-in counter demands dedicated by check-in alliance (NS11 typical busy day in a week—Tuesday).

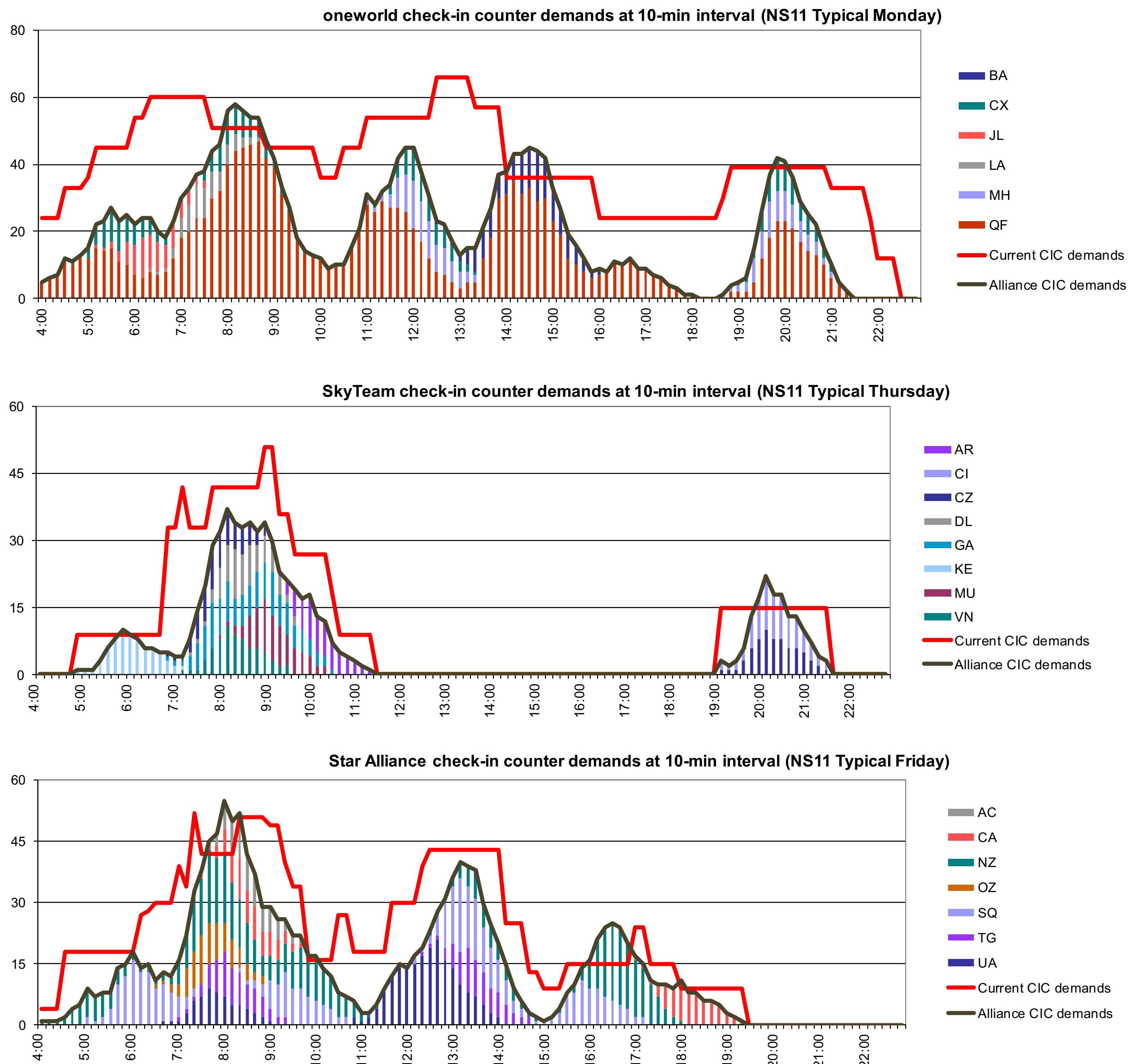

Fig. 2. International terminal check-in counter demands by alliance (NS11 typical busy day in a week) Note: airline codes used in Fig. 2 represent the following: BA (British Airways), CX (Cathay Pacific), JL (Japan Airlines), LA (LAN Airlines), MH (Malaysia Airlines), QF (Qantas Airways), AR (Aerolineas Argentinas), CI (China Airlines), CZ (China Southern Airlines), DL (Delta Air Lines), GA (Garuda Indonesia), KE (Korean Air), MU (China Eastern Airlines), VN (Vietnam Airlines), AC (Air Canada), CA (Air China), NZ (Air New Zealand), OZ (Asiana Airlines), SQ (Singapore Airlines), TG (Thai Airways) and UA (United Airlines).

case airport and flight destinations and 2) home carrier rotating aircraft for maintenance and rostering purposes.

The focus of this scenario study was to review the possibility of further concentrating aircraft parking of alliance member airlines at some of their already-established locations at the international terminal. The existing concentrations of oneworld and Star Alliance carriers at its two concourses were prioritised in this analysis, citing a lack of code-share activities and physical lounge tenancies among SkyTeam carriers at the case airport. Other than the realigned concourse preferences for the alliance affiliated airlines, aircraft parking allocations in this proposed scenario were conducted entirely in accordance to the airport operator's existing Gate Allocation Procedures. The key indicators adopted in this paper to evaluate operational efficiency of the alliance-driven terminal aircraft parking allocation were: 1) the number of irregular assignments such as cross-pier departures and remote bussing operations and 2) the number of aircraft towing activities.

In the results of the base case allocation, there were four cross-pier arrivals and two cross-pier departures among the aircraft parking allocations for the typical busy day (Saturday). Modelling results of the proposed scenario under alliance co-location showed that oneworld and Star Alliance flights co-located at their concourses, respectively. The gate-to-gate walking distance for connecting passengers was reduced after removing the previous six cross-pier allocations. The aircraft parking of SkyTeam flights concentrated at selective positions across the two concourses for potential common ground handling. All non-aligned carriers' departure flights were assigned according to their individual pier preferences. These were achieved by swapping and relocating the bay allocations of flights, particularly during the terminal's busy periods (0600–1000 h).

Overall, this has resulted in four additional towing activities for the day with three of them occurring during the morning peak. However, these changes have collectively ended one of the two departure flights previously facilitated by bussing operations between the main terminal and remote parking stands. Based on the case airport's conditions of use of terminal facilities, this also eliminated the $336 (168 seats at $2 per chargeable passenger) "Bussing/Stand-off position discount" the airport operator was required to reimburse its airline customer for embarking the airline's passengers at an off-terminal bussing position.

The co-location of alliance aircraft parking has demonstrated improvements over service delivery to airlines and their connecting passengers, while the operational efficiencies of the terminal's aprons and ground handling resources (e.g. aircraft tugs) were slightly compromised due to additional aircraft towing activities. As a by-product to alliance terminal co-location, the designation of alliance aircraft parking at various terminal areas could potentially allow the airport operator to transfer the planning of aircraft parking assignments to its key airlines (e.g. local alliance co-ordinators), leaving the airport operator fewer stakeholders to deal with over aircraft parking co-ordination on the day of operations. This practice has also been noted at two of the three sample airports previously discussed in our case analysis, i.e. Paris Charles de Gaulle and Tokyo Narita Airport.

5. Discussion and conclusion

The study of the case airport has confirmed that the implementation of alliance terminal co-location could yield operational and financial merits for the airport operator, similar to those observed at the sample airports. However, the concept could not be executed entirely the same way at the case airport, as its operating environment is fundamentally different to those of the sample airports. Lessons learned from the case airport are summarised by the following: first, at all three sample airports, the implementation of alliance terminal co-location took place after the completion of major airport expansion, when new terminal capacities were made available. The situation is different at the case airport, as the concept was aimed for resource savings to ease existing international terminal capacity constraints without terminal expansion. In this regard, the application of alliance check-in co-location would allow the case airport to take advantage of a more streamlined and constant demand of counters over a long period of time, which is not attainable by allocating check-in resources to individual flights.

Second, unlike the sample airports—where international traffic can be allocated to different terminals by alliance alignments—the reshuffle of international aircraft parking at the case airport was only limited to the international terminal (to maintain existing terminal traffic designation). While London Heathrow Airport has experienced benefits such as a reduced number of runway crossings following the relocation of British Airways to T3 and T5, potential synergies to be generated by alliance terminal co-location at the case airport were more limited to the reduction of passenger bussing operations to remote aircraft parking stands, and concentrated aircraft parking for common ground handling.

Overall, the concept of alliance terminal co-location has presented operational and financial merits for the airport operators. However, not all airports have been significantly impacted by the emergence of airline alliances, as many continue to operate without any alliance affiliated airlines. Therefore, the implementation of this concept should not be done through a one-size-fits-all approach considering the hard-to-replicate combinations of diverse resources and stakeholders at various airports. For those network hubs exposed to multiple alliance memberships, the airport operators should carefully take their operating environment and proximity needs into account when contemplating which airport resource(s) to include when applying an alliance-driven allocation. Airline alliances remain fluid in membership, and airport operators need to ensure that their facilities and services are capable of adapting to change in the future.

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