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AIR-FREIGHT LOGISTICS

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1. Introduction

The air transport industry has gradually increased its share of global passenger and freight traffic, largely at the expense of rail transport (Button et al., 1998). This trend has accelerated in the last 30 years. For the past decade, air-freight traffic growth has outpaced air passenger traffic growth by 1-2% points each year. The air-freight sector has been transformed since the late-1970s. Prior to deregulation of air cargo in the U.S.A. in 1977, the industry offered limited products, with heavy reliance on several intermediaries and a significant dependence on air passenger operations. The industry can now be characterized as a sophisticated, innovative sector relying heavily on new electronic technologies and offering a wide range of transport and logistical products through dedicated specialist cargo operators. With increasing emphasis on the globalization of trade and economic activity, air-freight growth is expected to continue to outpace air passenger traffic growth and be greatest in Asian markets (i.e., intra-Asia, North America-Asia, Europe-Asia, Australasia), despite the recent economic crises in the region. The correlation between world gross domestic product (GDP) and world air-freight traffic forms the basis for traffic forecasts. Because of the cyclical nature of GDP growth, air-freight traffic growth is also subject to cyclical effects.

The process of physical distribution of freight has become a highly sophisticated operation, with increasingly greater reliance being placed on the use of new technology to assist in the movement, storage, and tracking of consignments. Transport is but one component in this logistics chain. In this chapter, the air-freight sector is examined in terms of its structure, organization, and role in the supply chains of shippers. Section 2 looks at the organization and structure of the air-freight sector, identifying the main groups of players and their distinguishing characteristics. Section 3 examines the main issues influencing pricing in the sector. This is followed in Section 4. by an overview of the main trends in the industry in the recent period, which are heavily influenced by U.S. domestic market trends. The final section looks at constraints facing the sector and the future prospects for the industry, particularly in light of the reshaping of consumption patterns facilitated by electronic commerce.

2. Air-freight industry organization

Air-freight markets are difficult to delimit and analyze, for a number of reasons. The air-freight providers are a heterogeneous group of operators, offering different types of services and different levels of logistical expertise. There are three main categories of air-freight operators:

- (1) line-haul operators,
- (2) Integrated/courier/express operators, and
- (3) niche operators.

Line-haul operators move cargo from airport to airport, and rely on freight forwarders or consolidators to deal directly with customers. Line-haul operators can be:

- (1) *All-cargo operators* (scheduled and non-scheduled), moving only freight in dedicated freighter or cargo aircraft (e.g., Cargolux (European Union(EU)), Arrow Air (U.S.A.)). All-cargo operators offer relatively high reliability and have the capability to move large volumes over long distances.
- (2) *Combination passenger and cargo operators*, which use both dedicated freighter aircraft and the belly holds in passenger aircraft to move freight (e.g., Lufthansa (EU), United Airlines (U.S.A.)). For the combination carriers, the cargo operations are mainly long-haul, with a large amount of freight being interlined on to shorter haul feeder services. The high utilization of long-haul aircraft justifies the purchase of new aircraft for these services.
- (3) *Passenger operators*, which use the belly holds in passenger aircraft. Passenger carriers have tended to view cargo as a by-product of passenger operations. They are seen to offer the lowest prices and the least reliable service (GECAS, 1994). Passenger carriers move cargo in the belly holds of passenger aircraft, where it has traditionally taken second place to passenger services. Unlike passenger services, shippers do not have access to price information analogous to passenger computer reservation systems (CRSs). Freight forwarders play an important role in consolidating shipments for line-hauliers.

Integrated/courier/express operators move consignments from door to door, with time-definite delivery services (e.g., UPS, Federal Express, TNT, DHL). These integrated carriers operate multimodal networks, combining air services with extensive surface transport to meet customer demands. The integrators offer a variety of products to shippers, and supplement air services with extensive ground transport to provide time-definite delivery with continuous shipment tracking and, if necessary, logistical expertise to support just-in-time (JIT) inventory control strategies. In order for integrators to be able to offer door-to-door next-day deliveries, they require night-time operations. In terms of aircraft requirements then, they need to operate quiet, reliable aircraft with low utilization levels (as few as 2 hours/day flying time in some cases). Integrators seek to purchase a

combination of new aircraft, with high capital costs and better utilization on long-haul segments, with less expensive renovated second-hand aircraft for the medium-haul operations with lower utilizations. The integrated carriers initially began offering services in the small parcel/document sector, but now typically offer a broad range of services in terms of maximum weight and dimension restrictions. The association of integrators with purely express freight is no longer valid. The integrators have focused their attention on the premium high-yield traffic. Legislative changes in the U.S.A. have permitted *integrated freight forwarders* (e.g., Emery Worldwide, Airborne Express (U.S.A.)) to line-haul their consignments themselves, and since 1994 interstate ground operations for all carriers have been deregulated.

Niche operators operate or leverage specialized equipment, or indeed expertise, in order to fill extraordinary requirements (e.g., Heavylift (The Netherlands) and Challenge Air Cargo (U.S.A.)). These operators attract business through their capabilities for handling outside freight or special consignments, including line-haul to locations with poor infrastructure facilities. For chartered freight and niche operators, the discontinuous use of aircraft makes it financially preferable to acquire freighter aircraft on a second-hand basis.

The air-freight industry was dominated until the mid-1980s by the line-haul carriers. The integrated carriers rapidly increased their market share in the U.S. domestic market (following deregulation in 1977), and more recently in international air-freight markets (Carron, 1981). There are several important distinctions between passenger demand and shipper demands for air transport services. These distinctions place a different set of constraints and operating conditions on carriers depending on whether they are carrying cargo, passengers, or both. Freight comes in a large variety of shapes, densities, and sizes, and must be loaded onto and off aircraft by equipment and handlers. Large units may have to be carried in freighter-only aircraft. The routing of cargo (including the number of stops or transfers) is unimportant to the shipper. What is important is the lapsed time between pick-up and delivery. For passengers, however, their preference is typically for daytime, non-stop flights. Shippers' preferences are for night-time carriage of goods, with early morning delivery.

One of the most significant differences between passenger and freight air transport (a factor which significantly affects the economic viability of cargo operations) lies in the fact that passengers typically travel on round-trip journeys,

Table 1
Air-freight tonnage for the top 20 freight airports (1998)

Cargo rank	Airport	Region	Airport code	Freight (tonne)	% change in freight 1997-1998	Airport rank for passenger volumes
1	Memphis	U.S.A.	MEM	2 368 975	6.1	87
2	Los Angeles	U.S.A.	LAX	1 861 050	-0.7	3
3	Miami	U.S.A.	MIA	1 793 009	1.5	12
4	Hong Kong	Asia	HKG	1 654 356	-8.8	23
5	Tokyo	Asia	NRT	1 637 521	-5.8	32
6	New York	U.S.A.	JFK	1 604 422	-3.7	16
7	Frankfurt/Main	Europe	FRA	1 464 955	-3.3	7
8	Chicago	U.S.A.	ORD	1 441 829	2.5	2
9	Seoul	Asia	SEL	1 425 009	-9.1	20
10	Louisville	U.S.A.	SDF	1 394 999	3.7	171
11	Singapore	Asia	SIN	1 305 592	-3.9	34
12	London	Europe	LHR	1 301 251	3.3	4
13	Anchorage	U.S.A.	ANC	1 289 266	2.3	144
14	Amsterdam	Europe	AMS	1 218 746	0.9	11
15	Newark	U.S.A.	EWR	1 094 383	4.5	13
16	Paris	Europe	CDC	1 067 255	-0.5	9
17	Taipei	Asia	TPE	916 881	0.4	58
18	Atlanta	U.S.A.	ATL	907 208	4.9	1
19	Dayton	U.S.A.	DAY	893 239	9.8	240
20	Indianapolis	U.S.A.	IND	812 664	22.6	115

Source: Airports Council International (1999).

while cargo travels from a point of production to a point of consumption. Matching demand with inbound and outbound capacity is a difficult task and can lead to different network organizations for freight services compared with passenger services. For combination carriers, this can pose difficulties, since freight demand and passenger demand for principal destinations may not coincide. Carriers will take account of inbound and outbound requirements in considering whether or not to provide service on a route, and in deciding on the segments of the route and capacity available on each of the segments. Table 1 lists the top 20 air-freight airports in the world in 1998. The table includes the rank of each airport in terms of air passenger traffic, and highlights the distinctions in network organization of combination carriers and integrated carriers. The line-haul combination carriers tend to focus their cargo operations on international gateway airports, allowing consolidation or break-out loads to be transferred between long-haul and short-haul services. The integrated carriers focus their

operations at cargo hubs that do not necessarily have very high volumes of

passenger traffic. Memphis and Indianapolis airports in the U.S.A. are principal and secondary hubs, respectively, for Federal Express; Louisville, also in the U.S.A. is the primary hub for UPS; and Dayton is the primary hub for the U.S.A. integrated forwarder Emery Worldwide.

3. Air-freight pricing

Air-freight services are sold and marketed in a number of different ways. The line-haul operators sell a relatively small proportion of their cargo space directly to their customers. The greater proportion of their space is sold through general sales agents (GSAs) or freight forwarders, who negotiate with the airlines for fixed amounts of space. The agents or forwarders then sell on the freight space to customers.

The line-haul airlines publish their cargo tariffs as agreed at International Air Transport Association (IATA) tariff conferences. In practice, only a small percentage of customers pay these published tariffs, which can be considered as an upper-band on air cargo rates. As with passenger fares, discounting is widely applied, and in the case of cargo the rates will be determined on the basis of a number of characteristics and circumstances, including the following:

- (1) volume, density, and weight;
- (2) commodity type;
- (3) routing;
- (4) season;
- (5) regularity of shipments;
- (6) imports or exports; and
- (7) priority or speed of delivery

Consolidated shipments, aggregated by forwarders and carried by the line-haul operators, typically travel under a single air waybill (AWB). The freight forwarders bundle a variety of services and expertise and offer shippers a wide range of logistical and transport options. These include collection and delivery of shipments door to door, complete paperwork and documentation for customs purposes, customs clearance, tracking of shipments, and inventory management and control. The freight forwarders act as wholesalers and earn their profit by maximizing the difference between what they pay airlines and other carriers and what they can charge shippers. The integrated operators offer a variety of products or services depending on (1) the weight of the consignment and (2) the speed of delivery required by the customer. Discounting is applied to these services on the basis of the volume and regularity of custom. However, because

each consignment is treated as a separate piece of freight, with an individual AWB and customs declaration, the integrated carriers provide and practice electronic tracking of individual shipments, and levy charges individually. Customs services in many jurisdictions now operate electronically, so that consignments receive clearance en route to their destination airport. The customs authority can notify the operator of consignments that will need to be cleared on the ground, and this information can be forwarded to the customer via the tracking system.

4. Recent trends in air freight

In global terms, the dominant air cargo flows are in three main markets: Asia-North America, the North Atlantic (i.e., North America-Europe), and Europe-Far East. The Europe-Asia market is expected to have one of the top growth rates over the period 1997-2017. Boeing (1998) estimates that air freight on this sector will grow by 7.3% per annum. Indeed, any markets involving Asia are expected to experience the highest growth rates in the next 10 years. Intra-Europe freight has the lowest forecast growth rate of 4.5%. The international air express market is expected to grow at a tremendous rate over this period, and this market is served primarily by the integrators. Boeing forecasts an annual growth rate of 18%, which they claim will result in express services accounting for approximately 40% of the total international cargo business by 2015. It currently accounts for 5% of the total market. This mirrors the U.S. experience, where express services accounted for 4% of the U.S. market in 1977, and with an average annual growth rate of 25% express operators or integrators claimed in excess of 60% of the U.S. domestic market in 1998. It is believed that this experience in the U.S. raised customer expectations for air-freight services worldwide.

Air-freight markets are shifting as the economic growth pattern of developing countries accelerates past that of already industrialized economies. The main influences or drivers behind these trends are (Reynolds-Feighan and Durkan, 1997):

- (1) the primary influence of world economic activity (world GDP is the best single measure of global economic activity, with a high correlation between changes in world GDP and changes in world air cargo revenue tonne-kilometers (RTKs));
- (2) the impact of the range of services in the express and small package market;
- (3) inventory management techniques;
- (4) deregulation and liberalization;
- (5) national development programs; and
- (6) the stream of new air-eligible commodities and the growth of e-commerce.

Air-freight is a significantly more expensive mode of carriage of goods than other modes, and will be used when the value per unit weight of shipments is

relatively high and the speed of delivery is an important factor. Under these

circumstances, the transport costs can comprise a small proportion of the revenue associated with the products. The advantages which movement by air offers shippers are the speed, particularly over long distances, the lower risk of damage, security, flexibility, accessibility for customers, and good frequency for regular destinations (Simmons, 1994). For integrated operators, the guaranteed delivery and the facility to track consignments gives customers additional advantages over standard air-freight carriage. These superior qualitative differences give rise to higher rates for integrated services. Over shorter distances, air transport faces stiff competition from surface modes and from combined road and sea services. Air-freight demand varies by season, and this is taken into account by carriers supplying airlift capacity.

The passage of the Domestic All-Cargo Deregulation Statute of 1977 in the U.S.A. eliminated the Civil Aeronautics Board's (CAB) control over entry into and exit from the all-cargo market (Carron, 1981). Control over air-freight rates was curtailed and eventually eliminated. Carriers were permitted the right to refuse specific types of freight, and they became liable for the full value of the freight carried. The deregulation of air freight raised cargo rates as expected (Taneja, 1979), but gave shippers greater choice among carriers with respect to rates, consequential damage, and excess value charges (Taneja, 1979). Under CAB regulation of air freight, all-cargo operators were unable to generate reasonable profits with the result that the quantity and quality of service were deteriorating. Furthermore, it was generally felt that freight carried by air traveled longer distances than was necessary because surface modes could not be used to support the carrier's operation (Taneja, 1979). Integrated carriers now offer multimodal services that take advantage of the distance, cost, and time trade-offs offered by the different modes. In the European and Asian markets the integrated carriers have recently increased the size of their international operations. Indeed, within Europe, it is estimated that the integrated carriers now perform most of the total intra-European RTKs (Reynolds-Feighan, 1994).

Within Europe, competition from surface modes has had, and will continue to have, a downward impact on air-freight growth rates (4-5% per annum for 1997--2017). This factor, along with a relatively low overall economic growth rate, explains the below average long-term growth rate for air freight. "Air trucking," which involves the movement of air cargo by road under AWB, has been expanding at a rate of 15% per annum since 1975, according to Boeing (1998), with an estimated 7340 trips per week in Europe in 1997. Boeing suggests that the number of routes served within Europe has expanded from 38 in 1975 to 386 in 1995. In 1971, international airlines through IATA introduced and adopted IATA Resolution 507b, which clearly defined the circumstances under which trucking could be undertaken. The main circumstances involved:

(1) a lack of available space on aircraft;

Table 2
Comparison of integrated and non-integrated services

Integrated carrier/freight forwarder

Non-integrated operation with air trucking

Integrator:

Picks up consignment
Tags and electronically traces consignment until delivery
Line-hauls package from airport to airport Clears customs
Delivers to destination

Shipper

Agent:

Consolidates multiple shipments under a single AWB
Delivers to airport bond

Air trucker:

Picks up consignment and delivers to another airport bond

Airline:

Line-hauls consignment from airport to airport

Agent:

Arranges customs clearance, collection and delivery

Consignee

- (2) consignments that could not be handled on aircraft operated by an airline due to the size, weight, or nature of the consignments (certain commodities may only be shipped in freighter or all-cargo aircraft), or because the carrier refused carriage on some other grounds;
- (3) carriage by air would have resulted in delayed transit times or in carriage not being accomplished within 12 hours of acceptance; and
- (4) carriage by air would have resulted in missed connections.

Today the practice of air trucking is predominantly oriented towards moving intercontinental freight traffic to gateway airports. This process is shown diagrammatically in Table 2, which helps to illustrate the distinguishing characteristics of non-integrated operations compared with integrated operations.

5. Constraints and future prospects

Several factors can be identified as significant constraints on the growth of air freight. These include the significant growth of air trucking and the reduction in freight carrying capacity of the passenger airlines. In the longer term, the integrated operators and all-cargo airlines can be expected to increase their share of the air-freight market, as passenger carriers are forced to charge more realistic cargo rates that are in line with the costs of producing the services.

Passenger carriers have been facing declining passenger and freight yields (revenue per seat-kilometer or tonne-kilometer) as competition has forced efficiencies on many aspects of their operations.

Environmental regulations have impacted on the air freight sector by forcing a reduction in the number of older, noisier aircraft available, and have delayed or altered the infrastructure planning process and contributed to the capacity constraints at many airports, particularly in Europe. The noise and pollution requirements now in place at many of the large airports raise operating costs for many carriers. The congestion of air transport infrastructure has been identified in several studies as a major bottleneck in the development of competitive air passenger and freight transport markets in domestic and international markets (Reynolds-Feighan and Button, 1999). Finally, security problems are a significant factor constraining the growth and development of both express operations and air trucking.

The emphasis on multimodal transport operations and on greater integration of transport with other logistical services will dominate freight developments in the next two decades. While e-commerce eliminates the need for the physical distribution of some products and services, it is dramatically altering the pattern of consumption and generating new sources of business for the air-freight industry.

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