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Air Freight: A Market Study with Implications for Landlocked Countries

TRANSPORT SECTOR BOARD

International Trade Department The World Bank

AIR FREIGHT: A MARKET STUDY WITH IMPLICATIONS FOR LANDLOCKED COUNTRIES

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FOREWORD

It is a pleasure to welcome this study on air freight which has been skillfully created by a team of World Bank professionals. This publication, which contains a comprehensive analysis of issues related to air freight, addresses in detail air cargo operations in its most diverse dimensions.

Like other growing industries, the air freight industry is expanding exponentially. The issues faced by the industry are complex and their impact on other business operators is tangible. Transportation, an essential service relied upon by the air freight industry, makes it inevitable that this industry affects almost every other business and brings to bear its relevance and interest to business management.

There are few studies of this nature which have drawn information from a wide range of research in the manner in which the World Bank team of authors has accomplished, both effectively and adroitly.

I consider this study to be particularly valuable to the international aviation community, both in terms of its penetrating analysis as well as its well-reasoned economic discourse which culminates in down to earth and practical case studies. The thrust of this study brings to bear the important and useful role of air transport in the carriage of freight, as well as the compelling need to be aware of the implications that a global economic crisis, such as the one we are experiencing at present, has on the carriage of air freight.

Without doubt this study fits squarely within the mission of both the World Bank and the International Civil Aviation Organization (ICAO), which have been partners in offering to the aviation industry a series of annual air transport development fora in various regions of the world since 2005.

I am pleased to note that this publication is yet another step in the indomitable drive and conviction that our two organizations have in collaborating with each other to foster the development of air transport.

Dr. Taïeb Chérif
Secretary General
International Civil Aviation Organization

The capability of many poor countries to grow through trade integration and export development is constrained by physical constraints such as distance to market, but also by trade facilitation bottlenecks which can be even more daunting than distance. This is especially true for developing landlocked countries often dependent on a fragile transit system and long corridors just to connect to international shipping routes. For those countries, air transport has always attracted much interest as a mode of transportation that avoids the access challenge and meets the needs for nontraditional export opportunities notably for high value goods.

Several examples confirm the potential of air cargo for economic development of poor countries (including some of the least developed countries): fresh flower and fresh fish and sea food exports from Africa and Latin America are well known today. But these developments have been comparatively modest. The industries developed globally over the last decade along North-South routes linking rich countries and major emerging economies. In poor countries, the initiative came from the private sector, often starting from niche opportunities. There are also lessons to be learned on the enabling role of governments when it comes to trade facilitation initiatives at airports, liberalization or partnerships to facilitate the delivery of key services, and infrastructure.

Sustainability comes naturally to mind, as the last year saw dramatic negative trade developments for poor countries. Higher fuel prices and exit of key cargo providers in Africa point to dependences that the document also tries to analyze. Volatility and risks are significant and hamper the potential of air-freight for developing countries, as the availability and cost of service is very dependent on market trends in rich economies.

The reader will find here probably the first in depth look at this important topic in trade and development. It has been prepared by a team of experts with background in air-cargo, logistics, and development. We hope it will be of interest to a wide audience, including policy makers and development organizations. It provides a robust foundation and inputs for analyzing export diversification projects and initiatives. Finally this work should encourage further analysis and development of the theme of air freight, which is by essence going through rapid changes.

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Lastly, we would also like to acknowledge the participants who attended the World Bank's Brown Bag Lunches and thank them for their constructive feedback. We hope that this publication will encourage further substantive discussion on this topic.

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ABBREVIATIONS AND DATA NOTES

AAWH	Atlas Air Worldwide Holdings
APEC	Asia-Pacific Economic Cooperation
ATA	Air Transport Association
ATPA	Andean Trade Preference Act
FAK	Freight All Kind
FOB	Free on Board
FTK	Freight ton-kilometer
GSP	General System of Preferences
HCDA	Horticultural Crop Development Association
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
IPO	Initial Public Offering
IT	Information technology
JIT	Just in Time
Km.	Kilometer
LDC	Less Developed Countries
MAS	Malaysia Airlines
MJ	Million joules
mn	million
MRO	Maintenance, Repair and Overhaul
MTOW	Maximum Take-off Weight
OEM	Original Equipment Manufacturer
OEW	Operation Empty Weight
RFS	Road freight service
RTK	Revenue ton-kilometer
SAA	South African Airways
SEZ	Special Economic Zone
TACT	The Air Cargo Tariff (IATA)
ton	metric ton
UAE	United Arab Emirates
ULD	Unit Load Devices
U.S. DOT	United States Department of Transportation
USDA	United States Department of Agriculture

All dollar amounts are U.S. dollars unless otherwise indicated.
Billion means 1,000 million.

EXECUTIVE SUMMARY

To facilitate air freight, landlocked countries need to improve operations at their airports and liberalize access for foreign airlines. But until those countries become major exporters, it is unlikely that scheduled air cargo operators will have significant operations. Instead, most air cargo will move as belly cargo on passenger airlines, with some complementary use of chartered air freighters during shipment peaks. Landlocked countries should therefore provide greater access to foreign passenger airlines.

Potential markets

The demand for air freight is limited by cost, typically priced 4–5 times that of road transport and 12–16 times that of sea transport. Air freight rates generally range from $1.50–$4.50 per kilogram, while the value of air cargo typically exceeds $4.00 per kilogram. Commodities shipped by air thus have high values per unit or are very time-sensitive, such as documents, pharmaceuticals, fashion garments, production samples, electronics consumer goods, and perishable agricultural and seafood products. They also include some inputs to meet just-in-time production and emergency shipments of spare parts.

Demand for air freight exports has been limited from landlocked developing countries because most enterprises ship small volumes of low value goods. The main exports shipped by air from developing countries are cut flowers, electronic parts, and fresh fruits and vegetables. Imports by air typically include high value consumer goods. However, without a significant outbound flow, the inbound air freight rates are higher — reducing the types and quantities of goods transported by air.

Gaining competitive advantage

The use of air freight can create competitive advantages. For example, producers will agree to shorter order times if shipments possibly experiencing delays in production or cargo clearance can be shipped by air. Similarly, manufacturers of garments, electronics, and other goods will compete for larger orders by shipping the large initial order using ocean freight and then using air freight to replenish inventories if demand is greater than expected.

Diversifying

Air freight can also be used as part of a strategy for diversification — to introduce products with shorter shelf lives or to provide reliable delivery of smaller volumes in new markets. Once the market has been established and volumes increase, the manufacturer can reconstruct supply chains by using a less costly mode of transport.

These strategies are particularly important for landlocked countries that have unreliable land transportation or long and uncertain clearance procedures at their borders or foreign gateways. Finally, where exports require cold chains, air freight can present the only means for guaranteeing continuity.

Shipping samples

Air freight is critical in the shipment of product patterns, designs, and technical drawings. While this is not a major source of air cargo, it is critical for manufacturers who export manufactured products. More important is satisfying the need to exchange samples with potential buyers. For contract manufacturing, this includes the initial prototype sent for the buyer's approval so that the order can go ahead followed by a head of production run, which must be approved before starting full production. Samples may also be provided for testing or for promotion campaigns.

Types of service

As the volume of air freight grows, there is a natural progression from passenger aircraft to chartered cargo planes of increasing size and ultimately to scheduled cargo services. The challenge with using passenger aircraft is capacity, since priority goes to passengers and their baggage. For narrow-body aircraft with a high load factor, the available capacity is typically less than two tons, or about 12 cubic meters. Although load factors vary from flight to flight, shippers usually have a fixed shipment schedule based on the minimum available. Tourism can generate substantial freight capacity, but its cargo space is available only during the tourist season.

Chartered aircraft provide the shipper with more reliable capacity, but the freight rates are higher, especially for smaller cargo aircraft or for high load factors in only one direction (on a round trip or a triangular route). Capacity may also be a problem during peak seasons when all exporters compete for the available fleet capacity.

Most international scheduled air freight services operate on global east-west routes. They serve airports that are major generators of air cargo, avoiding airports that already have a significant amount of wide-body passenger aircraft traffic. They maintain high load factors throughout the year by using a mix of aircraft sizes and by periodically reallocating their fleet to different sectors.

To meet the demands of shippers exporting small volumes or cargos of median value, three so called hybrid services have been developed:

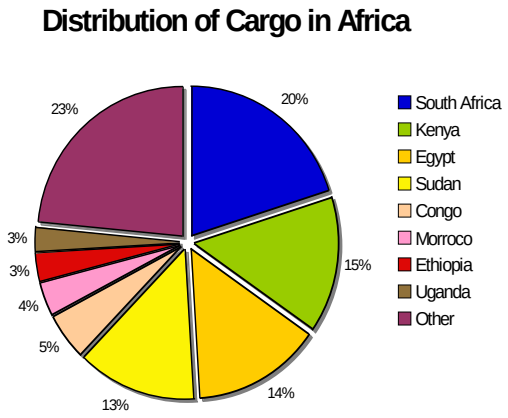
- The first relies on consolidators, which combine shipments to generate enough volume to obtain reasonable freight rates. The consolidated shipments are then flown to the nearest major transshipment hub where they are re-consolidated for their final destinations.

- The second involves freight forwarders who arrange for road transport from the cargo origin to the nearest hub airport. This involves a one-day (or at most two-day) trip and includes a border crossing if the hub airport is in a neighboring country. This type of road-air service is increasingly provided as part of an airline road-freight service, with goods transported by truck under the airway master bill.

- The third involves air and sea freight. An air-sea combination is typically used where there are convenient flights to a hub airport that has a major seaport nearby (Singapore, Dubai). Exports move from the point of production to the gateway port using air transport. This arrangement is used when exports have missed their shipment date and need to be loaded on a specific cargo vessel or when land transport to the gateway port in another country is costly, unreliable, or involves a difficult border crossing. The sea-air combination offers a lower freight rate than for an air shipment. For landlocked countries, this intermodal movement would be combined with initial movement by road.

Box A. Africa-Europe round trips

Europe is the primary destination for African air cargo accounting for about 2/3 of the total. African exports are typically counter-seasonal cut flowers and other perishables to Europe, but there is relatively little return cargo. More than half of the shipments are cut flowers and other refrigerated goods. The Netherlands are a major recipient of cut flowers, and Kenya is a major exporter. Manufactured goods are shipped primarily from South Africa, which accounts for almost 1/3 of the northbound air cargo. The southbound trade, the fastest growing, is primarily capital equipment, intermediate products and transport equipment. Together, these account for over half the shipments.



Tons loaded and unloaded at major airports
Source: Airports Council International

Kenya, South Africa, and Egypt handle about half the air cargo (see figure on the right). Sub-Saharan Africa has two airports with significant cargo operations, Johannesburg and Nairobi.[1] Johannesburg benefits from a strong local economy and a distance that requires air transport compulsory for most perishables exports to Europe. Nairobi has a relatively strong domestic demand for imports shipped by air as well as exports of cut flowers. It has leveraged this scale to become one of Africa's gateways. Nigeria benefits from the demand associated with its oil industry and other natural resources as well as relatively higher consumer demand. Cargo carriers have demonstrated an interest in serving this market despite problems with infrastructure and governance. Other countries with significant potential for agricultural exports by air, such as Uganda and Ghana, have difficulties with landside access and transport services, especially cold chains.

South African Airways, Kenya Airways, and Ethiopian Airways provide high quality air cargo services, often in cooperation with major international operators. However, most of the international gateways continue to rely on traditional European carriers that operate since the colonial period and have established regular routes.

Cargo airports

The main cargo-handling activities at the airport are receiving and delivering cargo, building cargo palettes, X-ray scanning of outbound cargo, clearing import and export cargo, and loading and unloading aircraft. Consolidation and short-term storage of cargo are generally performed on-airport by the airlines or cargo-handling agents or off-airport by forwarders. Recently, there has been an effort to consolidate these activities on airports through larger cargo terminals or cargo villages with multiple warehouses.

Airlines select an airport for major cargo operations based on the potential traffic. Nevertheless, little consideration is given to the physical characteristics of the airport other than length of the runway and approach control. The landside facilities are less important because they can be adapted to meet the traffic.

[1] Lagos in Nigeria has significant imports, and Khartoum in Sudan, had well in excess of 100,000 metric tons but much of this is attributable to relief supplies flown under contract by commercial carriers and charter operators.

Most landlocked developing countries have gateway airports that have a relatively simple configuration with small warehouses. Opportunities for improving the cargo facilities are often limited by the space available on the airport. However, as passenger traffic increases, many of these airports move to larger sites, allowing for modern cargo facilities. Even if they remain in the same place, it is often feasible to introduce multi-storey facilities with open cargo handling areas on the ground floor and office space for officials, airlines, and forwarders on the other floors.

Moving cargo quickly

Since the advantage of air freight is much shorter transit times, cargo must move quickly through an airport. The time for cargo operations depends on four factors: customs clearance procedures, cargo inspection procedures, the efficiency of cargo handlers, and the layout of storage facilities.

Customs clearing

For imports the customs procedures are critical. The clearance requires both the airway master bill, sent at the time the flight departs, and the customs declaration, filed by the brokers after the cargo had been shipped. In some countries the customs authority at the airport uses the same procedures and systems as at other international gateways, and inbound cargo can take up to a day to be cleared. In others the procedures are adapted to the requirements of air cargo, with all transactions conducted electronically and cargo cleared within one or two hours on a 24/7 basis.

Inspection equipment

For exports the documents are filed at the time cargo arrives at the airport, and the inspection is done at the same time so that cargo can be loaded within a few hours of arrival. Before X-ray scanners, a 24-hour cooling period was typically added to the transit time, but this has been eliminated. Most of the scanners are for baggage and small packages, so the cargo must be unloaded from the truck in loose form and scanned before being built into palettes. At larger airports with significant cargo traffic, full palette scanners allow shippers to build their palettes off-airport and to load them on the aircraft within a few hours.

Cargo handling

Cargo handlers at the airport should ensure efficient and secure handling of the cargo allowing airlines to compete with each other. Where the cargo volumes are fairly small, an exclusive contract is used, and the contractor must provide appropriate equipment for unloading the different types of aircraft.

In many developing countries the national carrier enjoys a monopoly, which presents a problem if the carrier is an inefficient state owned enterprise. This situation also introduces opportunities for discriminatory behavior in handling competitor's cargo. In some other airports a private contractor maintains a monopoly, but performance is often regulated through productivity incentives. Since the possibility for discriminatory behavior remains, competition must be introduced as soon as there is enough cargo, or carriers should be allowed to handle their own cargo.

Warehousing

Many storage facilities at smaller and older airports are fairly basic. This has little impact on cargo storage since most cargo does not stay at airports. Generally exports are time-sensitive, and the imports are high-value, fast-moving goods.

Modern warehouses have loading docks to speed truck turnarounds and minimize vertical movements of cargo. Export facilities for exports have large areas for scanning, inspection, building palettes, and gathering the cargo for specific flights. Separate facilities for imports have offices and inspection areas to facilitate customs clearance procedures and to allow for segregation of cargo into truckloads. For perishable cargo, these warehouses have temperature-controlled rooms for maintaining the cold chain between the truck and the aircraft. These warehouses also provide some bonded storage for high-value cargo.

Where there is enough traffic and space, airlines or larger forwarders will invest in such facilities. Where there is a lack of space or each airline handles a small amount of freight, the airport has to invest in a multiuser facility. In both cases, the airport must finance the construction of the complementary taxiways and the aircraft parking area.

Where these four elements, customs procedures, inspection equipment, cargo handling services, and warehousing are integrated into an efficient operation, most cargo will pass through the airport within a few hours. This minimizes dwell time and substantially reduces the space required to handle a specific volume.

Costs

As a result of the recent spike in oil price, fuel now accounts for about half the annual cost of operating an aircraft, whether for cargo and passengers. Because fuel consumption is roughly proportional to the aircraft weight and the distance flown, the marginal cost for carrying cargo is computed based on weight and destination. For belly cargo the space is offered “as available,” since priority goes to passengers and their luggage. Because the rate is usually set based on marginal cost and then adjusted for the level of service. For charter services the rates are usually higher, reflecting the incremental distance flown, including the empty legs, and the balance between demand and available capacity.

For shorter distances air freight rates per kilometer are higher because a greater part of the trip is spent both on the ground and more time in the air is spent climbing and descending. It is therefore often preferable to use road transport on the leg between the domestic source or destination and the transshipment hub.

Future air freight in landlocked countries

The main difficulty for landlocked developing countries is to generate enough traffic to attract air freight services that are both frequent and competitively priced. Permitting free competition, or “open skies,” for air cargo services can be significant but not sufficient if most cargo is transported as small shipments in passenger aircraft. Liberalizing passenger services to include fifth freedoms has been a greater challenge, especially in countries with a national carrier and limited passenger volumes. Also important is expanding the role of consolidators, especially the large integrators such as UPS, and the international freight forwarders specializing in air cargo such as Kelly Logistics, as well as local forwarders with international connections.

In the short run, higher fuel prices are expected to result in slower growth of air cargo traffic or even in a possible downturn. Over the longer run, traffic should continue to grow, but air freight will increasingly be integrated into multimodal supply chains that provide a better balance between cost and time.

Air freight will also open new markets by providing fast and reliable service for initial deliveries of product. Air freight will continue to support production activities, especially the exchange of samples and delivery of critical spare parts and high-value inputs. Finally, air freight will increase in importance in supporting reverse logistics, including repair and warranty work for electronics and other high-end consumer goods.

Nevertheless, air cargo is expected to decline as a mechanism for minimizing inventories and supporting just-in-time production. For these activities the higher cost of transport offsets the benefits of minimizing inventories in the supply chain. While it is important for potential exporters to have access to air freight services, they also must manage their supply chains to provide a competitive balance for the cost, speed, and reliability of shipments.

INTRODUCTION: ROLE OF AIR CARGO IN LANDLOCKED COUNTRIES

Potential market

The demand for airfreight is limited by cost which is typically 4–5 times that of road transport and 12–16 times that of sea transport.[2] The commodities shipped by air are those that have high value per unit density and/or are very time-sensitive. The latter include documents, production samples, perishable agricultural and seafood products,[3] electronic consumer goods, pharmaceuticals[4] and fashion garments. They also include emergency shipments of spare parts and some inputs to meet just-in-time production.

Landlocked developing countries have had limited demand for airfreight exports because the majority of the enterprises are SMEs which produce relatively small volume shipments of low value goods. Since airfreight rates range from $1.50-$4.50 per kilogram, the value of air cargo typically exceeds $4.00 per kilogram. The principal exports shipped by air from developing countries are cut flowers, fresh fruits and vegetables, and electronic parts. Imports shipped by air include a range of high value consumer goods. However, without a significant outbound flow, the inbound airfreight rates are higher, thus reducing the types of goods transported by air.

Airfreight can be used to obtain competitive advantage. For example, producers will agree to shorter order times assuming that those shipments that experience a delay in production or cargo clearance can be shipped by air. Similarly, manufacturers of garments, electronics and other goods will compete for larger orders by shipping the large initial order using ocean freight and then using airfreight to replenish inventories if demand is greater than expected.

Airfreight can also be used as part of a strategy for diversification. Manufacturers use airfreight to introduce products with shorter shelf life or to serve more distant markets with the same shelf life. Airfreight can also be used when diversifying into new markets to provide reliable delivery of smaller volumes. Once the market has been established and volumes increase, the manufacturer can reconstruct supply chains based on less costly transport. Manufacturers moving up the value chain in terms of product quality will use airfreight to reduce the order cycle especially for smaller, customized orders. These strategies are of particular importance for landlocked countries that have unreliable land transport options or lengthy and uncertain clearance procedures at their borders and foreign gateways. Where exports require cold chains, airfreight can present the only viable means for guaranteeing continuity.

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[2] Airfreight = $3.50 per kg for 15,000 kilometers, Road = $0.80 per kilometer for 15 tons, Sea = $3,500 for 15 tons for 15,000 kilometers.

[3] Most fish are shipped frozen and therefore transported by sea, but shellfish and fresh fish move by air.

[4] These are sometimes shipped by air but since most exports have relatively long shelf lives, they do not require rapid shipment.

Airfreight plays a critical role in the shipment of product samples. While this does not represent a major source of air cargo, it is critical for manufacturers who export manufacturing products. The exchange of trade documents is increasingly done electronically, but there is still a need to send patterns, designs, and technical drawings by air to smaller enterprises that lack the ability to reproduce these from electronic files. More importantly, there is a need to exchange various types of samples between manufacturers and potential buyers. In the case of contract manufacturing, this includes the initial prototype sent for the buyer's approval so that the order can go ahead followed by a head of production run, which must be approved prior to starting full production. Samples may also be provided for testing and/or promotion campaigns. Finally, samples shipped when there are changes in design for follow-on orders. Since each of these samples represents a sequential step in the order cycle, it is important that they be handled quickly to minimize the time required to complete the order.

Types of service

Most landlocked developing countries have relatively limited air transport services because of their size and level of economic activity. The domestic air network is usually a hub and spoke arrangement with the airport nearest the capital city acting as both the domestic hub and the international gateway. On the trunk routes, passenger aircraft are primarily narrow bodied with limited cargo capacity. On other domestic routes, smaller aircraft with little or no cargo capacity are used For international traffic, the national carriers serve relatively few international routes. Cargo is carried on passenger aircraft but these are frequently wide-body. National airlines also offer interline arrangements with international carriers, but the destinations are still limited, often overlapping routes already served by the national carriers. There is very little use of airfreighters other than occasional charters. However, in some of the larger developing countries air courier services have been introduced using cargo aircraft. The international air cargo shipped on passenger aircraft often goes to the nearest transshipment hub where it is transferred to the hold of another passenger aircraft or to a scheduled airfreighter.

As the volume of airfreight grows, there is a natural progression from passenger aircraft to chartered cargo planes of increasing size, and finally to scheduled cargo services. The principal difficulty with using passenger aircraft is the availability of capacity since priority is given to passengers and their baggage. For narrow-body aircraft with a high load factor, the available capacity will typically be less than two tons. Although load factor may vary from flight to flight, shippers usually have a fixed shipment schedule that is planned based on the minimum available. In developing countries tourism often generates substantial freight capacity, but this capacity is available only during the tourist season.[5]

The use of chartered aircraft provides the shipper with more reliable capacity, but the freight rates are higher, especially for smaller cargo aircraft or where it is not possible to maintain a high load factor in both directions (using either a round-trip or triangular route). Capacity may also be a problem during peak seasons when all exporters compete for the available fleet. Most international scheduled air cargo services operate on east-west routes and serve airports that are major generators of air cargo. They avoid airports that already have a significant amount of wide-body passenger aircraft traffic. They maintain high load factors throughout the year by using a mix of aircraft sizes and reallocating their fleet to different sectors periodically to maintain high load factors.

[5] For countries with year-round tourism, such as Kenya, this is not a problem.

In order to meet the demands of shippers exporting small volumes or cargoes of median value, a number of hybrid services have been developed. The first relies on consolidators, who combine shipments in order to generate sufficient volume to obtain reasonable freight rates. The consolidated shipments are then flown to the nearest major transshipment hub where they are re-consolidated for their final destinations.

The second involves freight forwarders who arrange for road transport from the cargo origin to the nearest hub airport. This involves a one-day, or at most two-day, trip and includes a border crossing if the hub airport is in a neighboring country. This type of road-air services is increasingly being provided as part of an airline RFS service (road freight service) in which the goods are transported by truck under the airway master bill.

The third involves a combination of air and sea freight. An air-sea combination can be used where there are convenient flights to a hub airport that has a major seaport nearby, for example Singapore or Dubai. Exports move from the point of production to the gateway port using air transport. This arrangement is used when exports have missed their shipment date and need to be loaded on a specific cargo vessel or when land transport to the gateway port in another country is costly, unreliable, or involves a difficult border crossing. The sea-air combination is used for cargo that requires a delivery time that is less than the ocean transit time but more than the transit time by air. The advantage is that it offers a lower freight rate than the air shipment rate. For landlocked countries, this intermodal movement would be combined with an initial movement by road.

Cargo airports

There are few airports that only handle cargo, or for which a majority of their traffic is cargo. These are primarily hubs for integrators such as FedEx and DHL. All but a few of the major hubs were originally built for passenger traffic and continue to handle significant passenger volumes. The few pure cargo airports are mostly converted commercial or military airports.

The principal cargo-handling activities taking place on the airport are receiving and delivery of cargo by the airlines, building cargo palettes, X-ray scanning of outbound cargo, clearing import and export cargoes, and loading and unloading of aircraft. Consolidation and short-term storage of cargo is generally performed on-airport by the airlines or cargo-handling agents or off-airport by forwarders. Recently, there has been an effort to consolidate these activities on the airport through the development of larger cargo terminals or cargo villages with multiple warehouses.

Airlines select an airport for major cargo operations based on the potential traffic. Little consideration is given to the physical characteristics of the airport other than length of the runway and approach control. The landside facilities are less important because they can be adapted to meet the traffic. Most landlocked developing countries have gateway airports that are relatively simple in configuration with small warehouses. Options for improving the cargo facilities are often limited by the amount of space available on the airport. However, as passenger traffic increases, many of these airports are moved to new, larger sites allowing for development of modern cargo facilities. Even if they remain in the same location, it is possible to introduce new, multi-storey facilities with open cargo handling areas on the ground floor and office space for officials, airlines and forwarders, as well as storage for equipment on the other floors.

Since the advantage of using airfreight is much shorter transit times, it is important that cargo moves quickly through an airport. The time required for cargo operations depends on four factors, customs clearance procedures, cargo inspection procedures, the efficiency of cargo handlers and the layout of

storage facilities. For imports, the customs procedures are critical. The clearance requires both the airway master bill, which is sent at the time the flight departs, and the customs declaration, which is filed by the brokers after the cargo had been shipped. In some countries, the customs authority at the airport uses the same procedures and systems as at other international gateways with the results that inbound cargo can take up to day to be cleared. In others, the procedures are adapted to the requirements of air cargo with all transactions being conducted electronically and cargo cleared within one or two hours on a 24/7 basis. This allows for cargo to be cleared within a few hours of the aircrafts arrival.

For exports, the documents are filed at the time cargo arrives at the airport, and the inspection is done at the same time so that cargo can be loaded within a few hours of arrival. Prior to the introduction of X-ray scanners, a 24-hour cooling period added a day to the transit time, but this has been eliminated. However, most of the scanners are for baggage and small packages requiring that the cargo be unloaded from the truck in loose form and scanned before being built into palettes. At the larger airports with significant cargo traffic, full palette scanners are being introduced which allow shippers to build their palettes off-airport and to load them on the aircraft within a few hours.

The selection of the cargo handlers at the airport is important not only to ensure efficient and secure handling of the cargo but also to allow the airlines to compete with one another. Where cargo volumes are relatively small, an exclusive contract is used and the contractor must provide appropriate equipment for unloading the different types of aircraft. In many developing countries, the national carrier is given this monopoly. This creates a problem where the carrier is an inefficient state enterprise. It also introduces opportunities for discriminatory behavior in the handling of competitors' cargo. In other airports, a private contractor is granted this monopoly but with performance regulated through productivity incentives. Since the possibility for discriminatory behavior remains, it is important to introduce competition as soon as there is sufficient cargo or alternatively allow the carriers to handle their own cargo if they wish to.

The storage facilities at smaller and older airports are often relatively primitive. This has minimal impact on cargo storage since most cargo does not stay in the airport. The exports are usually time-sensitive and the imports are high value, fast moving goods. The facilities do affect the handling of the cargo. Modern warehouses have loading docks to speed truck turn-around and minimize vertical movements of cargo. There are also separate facilities for exports and imports. The former have large areas for scanning, inspection, building palettes and gathering the cargo for specific flights. The latter have offices and inspection areas to facilitate customs clearance procedures and to allow for segregation of cargo into truckloads. For perishable cargos, these warehouses have temperature-controlled rooms for maintaining the cold chain between the truck and the aircraft. These warehouses also provide some bonded storage for high value cargo. Where there is sufficient traffic and space, the airlines or larger forwarders will be willing to invest in these facilities. Where there is a lack of space or each airline handles a relatively small amount of freight, it is the airport that has to invest in a multi-user facility. In both cases, the airport must finance the construction of the complementary taxiways and the aircraft parking area.

Where these four elements; customs procedures, inspection equipment, cargo handling services, and warehousing, are integrated into an efficient operation, then most cargo will pass through the airport within a few hours. This not only minimizes dwell time but also substantially reduces the space required to handle a specific volume.

Cost considerations

The principal difficulty for landlocked and other developing countries is to generate sufficient traffic to attract airfreight services that are both frequent and offer competitive rates. The liberalization of the market by permitting free competition, "open skies", for air cargo services can be an important step but may not be sufficient if most cargo is transported as small shipments in passenger aircraft. Liberalization of passenger services to include fifth freedoms has been a greater challenge, especially in countries with a national carrier and limited passenger volumes. Another important liberalization is expanding the role of consolidators, especially the large integrators such as UPS, and the international forwarders specializing in air cargo such as Kelly Logistics, as well as local forwarders with international connections.

As a result of the dramatic increase in price, fuel now accounts for over half of the annual cost for operating an aircraft. The proportion is similar for cargo and passenger aircraft.[6] Because fuel consumption is roughly proportional to the aircraft weight and the distance flown, the marginal cost for carrying cargo is computed based on weight and destination.[7] In the case of belly cargo, the cargo space is offered on an "as available" basis since priority is given to passengers and their luggage. Therefore the rate is usually set based to marginal cost and then adjusted based on the level of service. For charter services, the rates are usually higher reflecting the cost for incremental distance flown including the empty legs as well as the balance between demand and available capacity.

For shorter distances, air freight rates per kilometer are higher basis because a greater portion of the trip is spent both on the ground and more of the time in the air is spent climbing and descending, which has a higher rate of fuel consumption. For this reason, it is often preferable to use road transport on the leg between the domestic source or destination and the transshipment hub. If the hub is in another country, this requires transport under a transit document with minimum time and cost for crossing at the border.

Marketing and supply chain considerations

As already suggested, airfreight can be incorporated into a general marketing strategy for greater product value, product diversification and access to new markets. This requires constructing multiple supply chains not only for different products but also for the same product shipped to different markets. It involves using airfreight in different combinations with road and sea transport. Since it is costly, airfreight must be used selectively. This implies not only a careful analysis of the value chains for various product-market combinations but also a continuing effort to improve supply chains and adjust the use of airfreight in order to increase the value of delivered goods. Kenya's success in using airfreight to increase product value and maintain competitive advantage is a good example of such an effort.

The challenge in using airfreight effectively is to ensure that all components of the supply chain are performing efficiently. The airlines, especially the national airlines, can contribute to this effort. All cargo airlines are equipped to expedite cargo handling, but passenger airlines generally treat the

[6] Passenger aircraft are used more intensively, but their fixed costs for labor are much higher, so the proportion of fuel costs per revenue kilometer is similar.

[7] Because most cargo is low density, the rate is sometimes computed in freight tons, that is based on weight or volume whichever is greater. One metric ton is equated with 6 cubic meters, alternatively one kilograms and 60 square. centimeters.

cargo as an afterthought. For example, Colombia was able to develop its flower trade only after the national carrier recognized the importance of this cargo and improved its quality of service.

Airfreight is often used to compensate for delays elsewhere in the supply chain, in particular the supply of inputs. As these delays are eliminated through better management, there are opportunities to reduce costs by substituting ocean freight for airfreight. This has been the trend for exports of fresh fruits and vegetables. Precise schedule of the movement from farm to shelf have been complemented by techniques for extending shelf life to extend the range over which goods can be shipped by air while at the same time allowing air freight to be used to extend the market area for these goods.

Future role of airfreight in landlocked countries

At a time this report was prepared, the air cargo industry was entering a very difficult period due to a dramatic increase in fuel prices. In the short run, this is expected to result in slower growth or possible downturn in the air cargo traffic. Over the longer run, it is anticipated that traffic will continue to grow but airfreight will be integrated into multimodal supply chains that provide a better balance between cost and time. Airfreight will continue to be an essential mode of transport for extremely time-sensitive goods and for expansion into more distant markets as globalization continues. It will play a crucial role in developing exports for developing countries in general, and landlocked countries in particular. Perishables, especially fresh fruits and vegetables and chilled seafood, will continue to require shipments by air although an increasing proportion will use ocean freight as new sources are developed closer to the major markets. Airfreight will be used to open new markets by providing fast and reliable service for initial deliveries of products. It can also be used to ship the small volumes required during the initial market entry period. Airfreight will continue to support production activities, especially the exchange of samples and delivery of critical spare parts and high-value inputs. Airfreight will increase in importance in supporting reverse logistics, including repair and warranty work, for electronics and other high-end consumer goods.

The area in which the use of air cargo is expected to decline is its use as a mechanism for minimizing inventories and supporting just-in-time production. For these activities, the increasing cost of airport transport will offset the benefits from minimizing inventories in the supply chain. It is important for potential exporters to have access to airfreight services and to manage their supply chains to provide a competitive balance between cost, speed, and reliability of shipments.

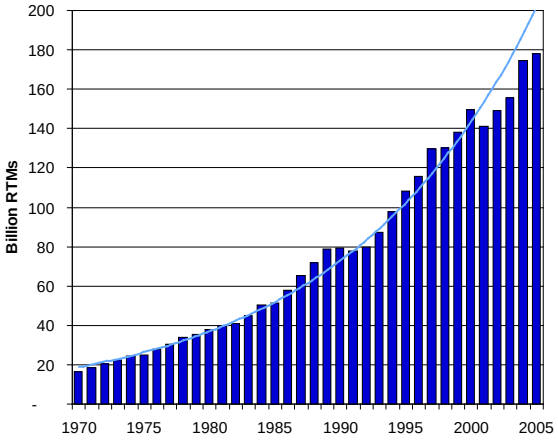
In order to facilitate the use of air cargo, landlocked countries will need to improve operations at their airports and to liberalize access for foreign airlines. It is unlikely that scheduled air cargo operators will have significant operations in landlocked countries unless and until those countries become major suppliers. Instead, most air cargo will move by as belly cargo on passenger airlines, with some complementary use of chartered air freighters during periods of peak shipment. Therefore, it is necessary to provide greater access for foreign passenger airlines.

The following chapters discuss the international air cargo industry in greater detail; examining the current demand in Chapter 1, nature of air freight services in Chapter 2, cargo handling operations in Chapter 3, and cost elements in Chapter 4. Chapter 5 presents some case studies of air freight being used to develop export activities in developing countries.

1 DEMAND FOR INTERNATIONAL AIRFREIGHT

Stages of growth

Figure 1-1. Air cargo traffic, 1975-2005



Source: Boeing

The international airfreight business has gone through a number of phases in the last half century while continuing to grow at over nine percent per year in terms of revenue ton-kms[8] (Figure 1-1, IPCC 1999). The total air cargo traffic carried on scheduled flights, as reported by the International Civil Aviation Organization (ICAO), experienced a sharp build-up in the decade following World War II. Traffic doubled due to the introduction of propeller aircraft capable of long haul, nonstop domestic and international service. Another surge occurred beginning in 1958 with the introduction of jet passenger aircraft, offering belly cargo capacity that greatly increased available lift while allowing passenger airlines to increase their participation in airfreight. This was followed with the introduction of jet freighters (B-707F, DC-8F) in 1963, and the wide-body aircraft in the 1970s. The latter increased not only capacity, but also efficiency supporting a rapid increase in international airfreight. The wide-bodied airfreighters also caused a substantial increase in market share for scheduled all-cargo services between East Asia and North America/Europe. However, this share subsequently declined in the late 1970s and early 1980s as a significant portion of the scheduled freighter services was replaced by charter services able to achieve higher load factors and greater flexibility by operating outside the restrictions of bilateral agreements. This led to a merger of scheduled and chartered air freighter operations with both combination carriers,[9] such as Lufthansa, and all cargo airlines, such as Cargolux, using the same fleet to provide both scheduled and charter flights.[10] At the same time, the air courier services began their rapid expansion in the United States and Europe. During this same period, the market share of cargo carried on passenger aircraft increased from its traditional 30–40 percent to slightly over 50 percent by the 1990s. This was accomplished through more flexible and competitive pricing in order to take advantage of the cargo capacity in their wide-bodied aircraft.

During the 1990s the air courier services expanded into the larger developing economies and extended their activities to include road and air services for both parcels and freight. While the overall growth of airfreight slowed in the 1990s the growth in domestic traffic in larger developing countries began to accelerate. National carriers in developing countries expanded their freight services by feeding cargo consolidated from their domestic networks to the international carriers. This was

[8] Throughout this report, tons mean metric tons.

[9] The air cargo industry has three primary types of carriers; combination carriers (passenger airlines that use a portion of their "belly-hold" capacity to carry cargo and may also operate separate air cargo fleets), conventional all-cargo carriers operating both scheduled and charter services, and integrated (express) carriers operating their own fleet of aircraft and delivery vehicles providing overnight, door-to-door service.

[10] The integrator DHL also has a significant charter operation based in Panama to increase utilization of its fleet.

followed by the introduction of express services, which provided both air and ground courier services. These integrated carriers have established a dominant position in domestic shipments of time-sensitive goods. They also developed relationships with the international courier services and in some cases were absorbed by them. During this period, the larger passenger airlines introduced road freight services (RFS) that allowed them to use trucking services to extend their area of service and thus emulate integrated services, but they still lost market share falling back to about 40 percent.[11] At the same time, sea-air shipments, which were first introduced in the 1970s, finally grew into a major business for Dubai and Miami. In recent years, new carriers have entered the scheduled airfreight business, in particular those in the Gulf States.

The percentage of cargo moving by air is negligible in terms of weight but significant in terms of value. For the U.S. international trade, nearly 30 percent by value is shipped by air, up from 16 percent in 1980. The percentage is higher for exports (about 35 percent) than for imports (about 24 percent).

As for the future, there remains considerable potential for growth in domestic movements in the larger developing countries as their markets become more time sensitive. Currently domestic traffic accounts for only one-quarter of the total airfreight (measured in revenue ton-km) and most of this is concentrated in North America and Europe.

Deregulation

The growth in air cargo has been assisted by two major initiatives to deregulate the market. The first occurred in the United States with the passage of the 1978 Airline Deregulation Act. Prior to that, entry to air cargo operations was limited to airlines that had offered prior service. The Act allowed any citizen seeking to operate an all-cargo airline to file an application for a section 418 certificate. Within one year of passage, major passenger airlines such as Delta, Continental, and Allegheny (now USAIR) submitted applications along with the major airfreight forwarders Emery and Airborne. Existing cargo airlines such as Flying Tiger and Seaboard used the law to expand their networks. This act also allowed a small express package service, Federal Express, which was using small commuter jets, to acquire larger aircraft, B-727s, B-737s, and DC-10s and to expand its network. Eventually there would be over 100 carriers obtaining section 418 certificates. Because of the high startup costs, most of these were established airlines. However, some were airfreight forwarders who would lease aircraft to serve markets where the belly capacity of passenger airlines was insufficient.

Markets outside the United States were slower to open their markets for either passengers or cargo. For most countries, the passenger market has only been opened during the last ten years with the introduction of low-cost operators, although the origins of this effort date back to the 1970s when People Express and Laker Airways attempted to open the U.S. and transatlantic markets. The opening of the air cargo market has been slower, in part because of limited demand—particularly in developing countries where demand has been adequately met with belly cargo of national carriers or through charter services.

The second major deregulation has been the move towards “open-skies” agreements. The basis for commercial air traffic between countries was established in the 1944 Chicago Convention (Annex A). This was predicated on utilizing bilateral agreements to permit flights between countries and through those countries to third countries. These agreements limited the number of flights, the size of aircraft

[11] IATA figures for 1999 indicate a market share of 42 percent for scheduled passenger services, 9 percent for pure charter operations and 49 percent for integrated all-cargo carriers.

and the participating airlines. The "open-skies" agreements are intended to eliminate these restrictions but within the context of bilateral agreements. While the introduction of this regime remains contentious for passenger services, there has been less resistance for cargo services. The agreements allow scheduled air cargo airlines to establish services to major markets with relative ease (charter flights are generally not restricted under the Chicago Convention), thereby allowing countries to expand into new markets especially for exports that are high value or time sensitive. These agreements are typically bilateral but there are a growing number of increasingly multilateral agreements, such as that between Singapore, Thailand and Brunei, as well as the APEC agreement involving eight states. There are also some unilateral agreements as in the case of India, Lebanon, Philippines and Kenya, which provide full liberalization for air cargo with or without reciprocity. Since 1992, there have been over a hundred bilateral agreements signed (about 2/3 involving the United States)., Sixty percent of those provide full freedoms including 7th freedoms (cabotage). The "open skies" agreement being negotiated between the United States and the EU will permit EU airlines to carry cargo between the United States and all third (non-EU) countries, as well as allow U.S. and EU airlines to enter into cooperative arrangements, including codesharing, franchising, and leasing. Even where there are no formal agreements, a large number (in excess of 120) of codesharing agreements exist that include air cargo, and effectively grant foreign partner airlines the same rights as domestic airlines.

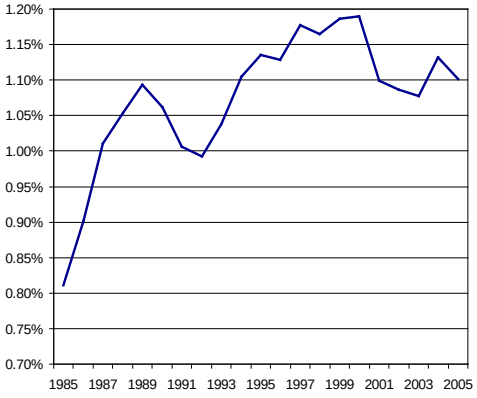
Nature of air cargo

The growth in airfreight over the last five decades has led to a diversification in the types of services and also the markets that are served. Most goods carried by air are high-value low-density cargoes, or time-sensitive goods such as perishables. The share (by value) of international freight traffic transported by air has increased. ICAO estimated airfreight accounts for about 40 percent of international exports by value, but the percentage based on weight remains close to one percent (Figure 1-2).

The basic commodity groups transported by air are:

- capital and transport equipment,
- computers, telecommunications equipment and other technology products,
- apparel and textiles,
- perishables and refrigerated goods,
- intermediate goods for distributed manufacturing, and
- other consumer products.

Figure 1-2. Market share of air freight



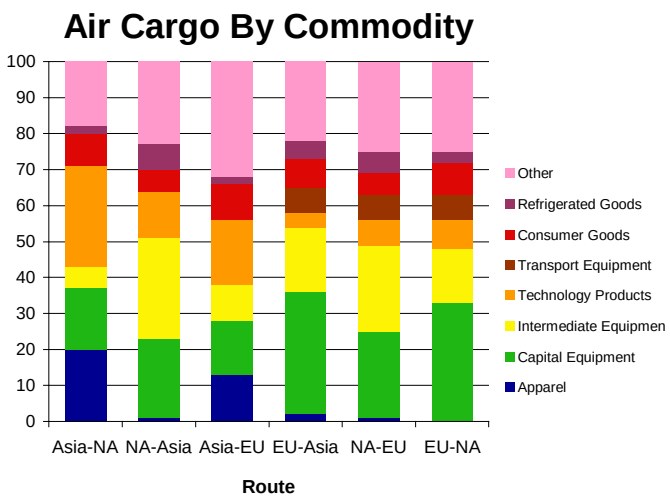
Source: Boeing

The proportion of traffic on the major trade routes accounted for by these commodity groups (as measured in FTK -freight ton-kilometers) is shown in Figure 1-3, based on estimates for the year 2005. Intermediate goods are important for the manufacturing and re-export trade in Asia. The trade in perishables reflects rising consumer demand for cut flowers, exotic fresh seafood, and counter-seasonal vegetables. The projected growth in traffic for these categories (as shown in Table 1-1), anticipates that globalization of production will continue increasing the share of capital equipment and intermediate goods. This would be followed by steady growth in shipments of electronics and perishables, but a decline in the share of apparel. The latter

reflects continuing improvements in supply chain management leading to a gradual shift of lower value, time-sensitive products to ocean transport.

Air cargo can be characterized according to the types of services required. There are currently four such categories: emergency freight, high-value freight, perishables and routine freight. Emergency freight includes time-critical shipments of spare parts and business and financial documents (where these cannot be transmitted electronically). High-value freight includes gold, jewelry, currency, artworks, electronic components and luxury vehicles. These utilize airfreight for security as well as speed. Perishables include fresh seafood, fruits and vegetables, pharmaceuticals and cut flowers. Airfreight provides most of the value added and usually accounts for a majority of the delivered price. Routine freight is the residual from which new categories are emerging. Among these are the rapid replenishment shipments, which are used to limit the amount of inventory when demand is volatile, for example in the markets for fashion garments or apparel with short seasons. It also applies to a portion of the just-in-time manufacturing process in which a short lead-time is combined with a flexible production line. Related to this are the missed shipment cargoes. These are cargoes that would normally use a slower, less costly mode of transport but because of delays in production or other problems have to be rushed to meet agreed delivery dates. Normally, this would have been included in the category of emergency freight, but use of these shipments has become a strategic decision wherein producers accept tight delivery schedules for competitive reasons but use slower transport with the understanding that a significant portion of shipments will become "rush shipments". There are also a number of emerging market niches that currently fall into one of the categories mentioned above but have the potential to become separate categories of airfreight. One example is shipments associated with Internet B2C (business to consumer) in which electronic retailers offer rapid delivery for impatient customers. While this has largely been limited to domestic shipments, there is every indication that this will become a small but important niche in global trade. Two other examples are military and relief supplies shipped to areas in conflict and project cargo, for example special equipment and machinery for specific construction or fabrication activities.

Figure 1-3. Air cargo by commodity



Source: Merge Global in Air Cargo World

Table 1-1. Projected share of growth in airfreight 2005-2010 (% of additional FTK)

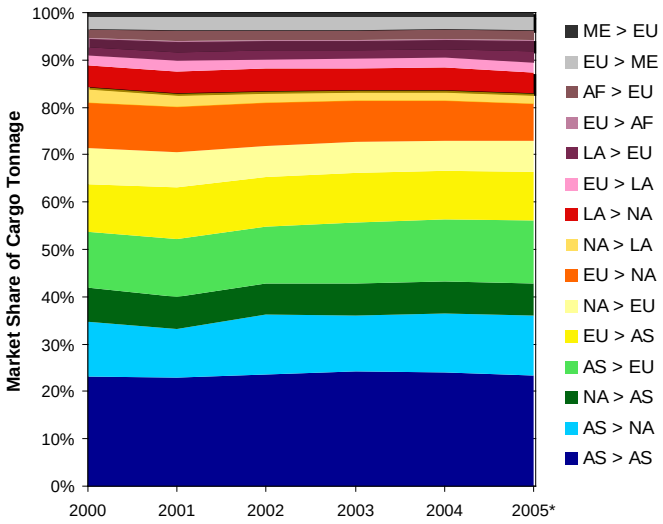
Capital Equipment	19.8%
Transportation Equipment	4.5%
Computers	11.2%
Telecommunications Equipment	6.1%
Technology Products	2.9%
Intermediate Materials	15.1%
Perishables	7.3%
Apparel	8.1%
Textiles	6.0%
Consumer Products	6.9%

Source: MGI Global Freight Model

Market concentration

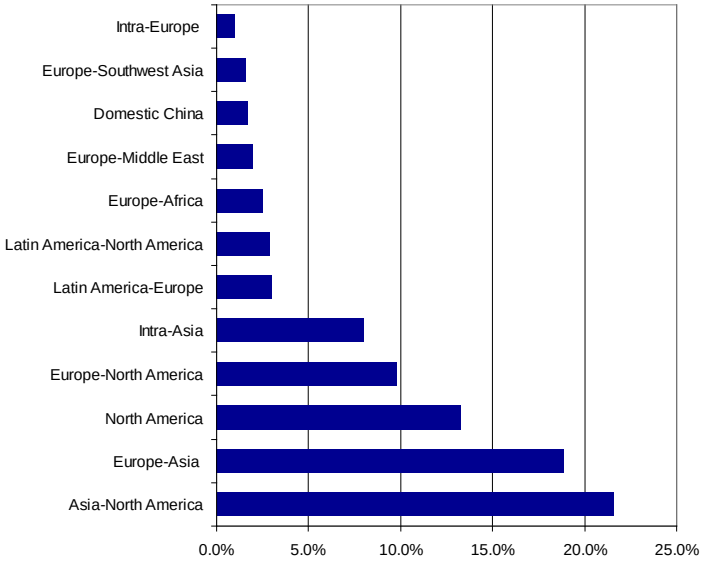
Air cargo is reported by airports in terms of weight handled, whereas airlines report the amount in freight ton-kilometers. Both are geographically concentrated, as is the underlying economic activity. Not surprisingly, most of the trade involves movements between North America, the EU and Asia, primarily China. Routes with origins or destinations in Asia account for 70 percent of the total volume of air cargo (Figure 1-4). Movements between Asia and both, the United States and Europe, account for 41 percent of total airfreight (Figure 1-5). In addition, the domestic movements in the United States account for about 13 percent and the shipments between the United States and Europe account for 10 percent. These percentages are likely to change as domestic shipments in North America stagnate (Table 1-2) and Asia continues to experience rapid growth, especially for routes serving China (Table 1-3). About 20 percent of the total volume is transported within Asia. Although important in terms of quantity of air cargo, this represents a relatively small portion of the freight traffic since such movements involve relatively short distances.

Figure 1-4. Air cargo by route



Source: MergeGlobal

Figure 1-5. Air freight market share by route



Source: Boeing

North America continues to account for the largest share of cargo handled in its airports (Figure 1-6), however, this share has been declining.[12] Also, it includes a large amount of domestic cargo. If only international trade is considered, then Asia has more air cargo than North America. Of the fifteen largest air cargo airports in the world, six are located in the United States and six in Asia. However, four of the top six are in Asia and this does not include Beijing, which, with a growth rate of about 30 percent is expected to rise quickly from its #20 rating in 2006. The Middle East, Africa and Latin America account for only about 11 percent of air cargo but there has been continuing growth in market share over the last decade.

[12] This number is also inflated by the large proportion of cargo that is transshipped at hub airports where they are counted both as arriving cargo and departing cargo.

Table 1-2. Average growth: value of U.S. air cargo (%)

Annual %	Total	Exports	Imports
1970–1975	20.5	20.0	21.2
1975–1980	25.2	24.8	25.8
1980–1985	6.9	2.6	12.9
1985–1990	14.2	16.1	12.1
1990–1995	12.0	10.4	13.9
1995–2000	10.8	9.4	12.1

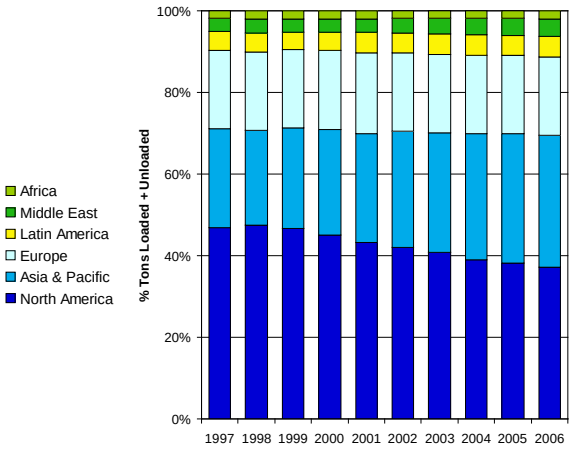
Source: U.S. Department of Transportation

Table 1-3. Projected rates of growth by route 2005–2025 (%)

Domestic China	10.8
Intra-Asia	8.6
Asia-North America	7.1
Europe-Asia	6.9
Europe-Southwest Asia	6.2
World	**6.1**
Latin America - N. America	5.6
Latin America - Europe	5.6
Europe-North America	5.4
Europe - Africa	5.3
Intra-Europe	5.0
Europe-Middle East	4.3
North America	3.8

Source: Boeing World Air Cargo Forecasts

Figure 1-6. Airport cargo traffic



Source: Airports Council International

Developing countries traffic

There are a number of factors limiting the volume of airfreight in developing countries. The principal constraint is the lack of balanced loads. Industrialized regions such as China's east coast are more likely to have significant volumes of two-way activity with inbound shipments of inputs for production helping to balance outbound loads comprised at least partially of finished products from those same inputs. For countries that do not have significant industrial production, the lack of consumer demand limits the potential for inbound air cargo to balance the outbound loads. International carriers attempt to mitigate the negative effects of directional imbalances by scheduling multiple stops to build volumes, rather than applying a strict round-trip routing. Because LDC's are often major producers of perishable cargo (particularly off-season fruits and vegetables), seasonality is an important factor in limiting year-round scheduled service. High shipping rates (costs) also result from a variety of additional operational risks. Other factors affecting demand for air transport include network factors, such as the role of airports as a domestic hub with linkages to local airports and as a gateway with linkages to international hub airports.

Asia continues to be the dominant market for air cargo in the developing world, as shown in Figure 1-7. Most of this is concentrated in East Asia (Figure 1-8) where the major exporters are located. The principal growth has been in shipments of intermediate goods to China and manufactured goods from China. This has led to a shift from using external hubs to establishing hubs in Beijing and Shanghai. This was made possible by the U.S./China Bilateral Agreement in July 2004 which allowed U.S. carriers to establish cargo hubs in China with no limitations on the 3rd, 4th, 5th and 7th freedom

rights, as well as more freedom to enter marketing and change of gauge[13] agreements with domestic carriers.

A significant portion of the air traffic is intra-Asian trade primarily of manufactured goods and intermediate products (Table 1-4). This is driven by the dispersion of production processes complemented by trade in intermediate goods on a just-in-time basis. Capital equipment and intermediate materials represent about 1/3 of airfreight within the region. China accounts for about half of the regional trade.

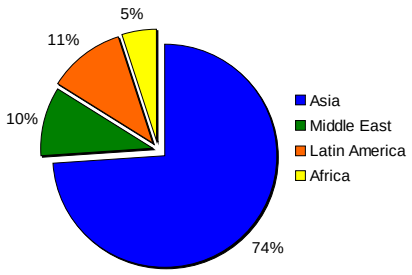
In Southeast Asia, the growth in air cargo in recent years has been slow but steady, reflecting the growth in economic activity. Singapore has managed to maintain a sizeable market share through efforts to maintain Changi as the regional hub supplemented with the development of a cargo village. Thailand's air cargo volumes are expected to experience faster growth with the opening of Suvarnabhumi airport, which will strengthen the role of Bangkok as an air hub, and encourage Thai International to establish an air freighter operation.[14]

South Asia has been slow to develop air cargo in part due to slower economic development and limited transport infrastructure. Recent acceleration in exports combined with an effort to modernize the airport sector will create new opportunities for air cargo. However, so far, the only segment that provides efficient and reliable service is air courier services, which has been growing rapidly. Despite these efforts, the countries in South Asia continue to be served from the regional hubs in the United Arab Emirates and Southeast Asia.

The largest quantity of intercontinental shipments is between Europe and Asia. Westbound flows accounted for about 1/6 of total intercontinental flows. About half of these are apparel, computers and capital equipment. For eastbound shipments

Figure 1-7. Distribution of cargo in developing regions

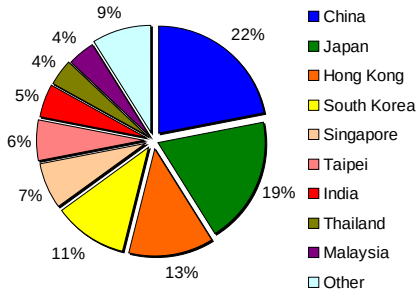
Tons loaded+unloaded at major airport



Source: Airports Council International

Figure 1-8. Distribution of cargo in Asia

Tons loaded+unloaded at major airport



Source: Airports Council International

Table 1-4. Commodities: Intra-Asian air cargo (%)

From To	Intra Asia
Capital Equipment	17
Transport Equip.	15
Refrigerated Foods	10
Computers	18
Apparel, Textiles	8
Other	32

Source: Merge Global

[13] Change-of-Gauge refers to an air transportation service operated under a single flight number but involving a change of aircraft en route.

[14] An earlier decision to do so has been delayed doe to difficult conditions in the airfreight business

about half are capital equipment and intermediate materials, but there is also a growing trade in high-value consumer products, especially cosmetics and leather products,

The second largest volume of intercontinental air shipments is between Asia and North America. The exports to North America have a similar composition and this trade is expected to continue experiencing strong growth. The shipments from North America are much smaller. About half of this is intermediate materials and capital equipment used in the production of goods for export to the United States.

For Latin America, the major air cargo trade is with North America. Most southbound shipments are intermediate goods and spare parts for manufacturing activities, predominantly in Brazil and Mexico. The final products are then re-exported to North America. There are also shipments of electronics, optical equipment, medical devices, aerospace equipment and pharmaceuticals from the United States. Northbound shipments from South and Central America and the Caribbean consist of fresh food and horticultural products, followed by apparel and capital equipment. The first two account for about 61 percent of the traffic (Table 1-5) but growth has slowed due to stagnant demand for cut flowers. There are also shipments of manufactured products including apparel, footwear, transportation equipment, and electronics. Brazil and Colombia are the major sources of air cargo with the former exporting footwear and other manufactures and the latter primarily cut flowers. The northbound traffic has been growing at twice the rate of the southbound cargo and is expected to continue doing so.

Table 1-5. Commodities: Latin American air cargo (%)

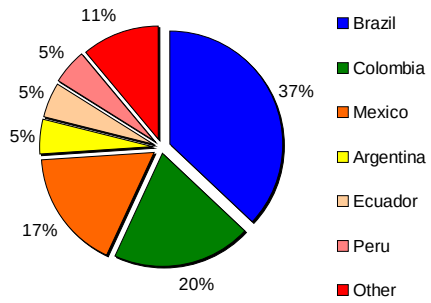
From	NA	LA	EU	LA
To	LA	NA	LA	EU
Capital Equipment	53	7	25	9
Intermediate Goods	8		27	11
Transport Equipment	7	4	13	8
Refrigerated Goods		53		41
Primary Foods		8		8
Computers	9			
Teleph,Tech Prod.	4			
Apparel, Textiles		9		
Consumer Goods			8	
Other	19	19	27	23

Note: NA (North America), LA (Latin America), EU (European Union)

Source: Merge Global

Figure 1-9. Distribution of cargo in Latin America

Tons loaded+unloaded at major airport



Source: Airports Council International

Latin American trade with Europe has expanded with increased westbound shipments of intermediate materials, capital equipment and transportation equipment to support manufacturing in the major markets (Brazil and Mexico) financed through European investments. About half the eastbound air cargo are food products. The eastbound trade also includes manufactured goods but most of this production is sent to North America and other Latin American countries.

Three countries, Brazil, Colombia and Mexico account for almost ¾ of the air cargo handled in Latin America (Figure 1-9). Brazil, the biggest exporter, has seven of Latin America's top twenty airports. The others have only a single national airport in the top twenty. Despite the quantity of cargo, neither Varig, Brazil's national carrier, or TAMPA, Colombia's all-cargo carrier, have been profitable. On the other hand, LanChile operating out of its hub in Santiago is one of Latin America's best-run carriers.

Growth of air cargo in Mexico's airports has been constrained by competition from road transport serving the United States and federal regulations that encouraged concentration of shipments in Mexico City airport. In Central America, Panama and Costa Rica have the largest air cargo volumes. The former acts as a regional hub for DHL, while the latter exports perishables.

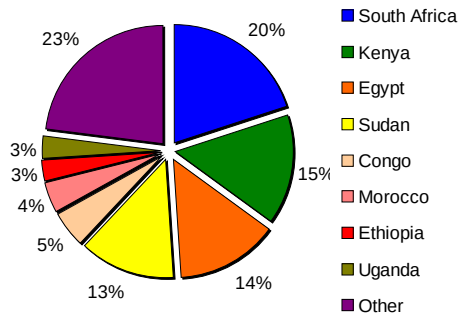
Europe is the primary destination for African air cargo accounting for about 2/3 of the total. The African exports are counter-seasonal cut flowers and other perishables to Europe, but with relatively little return cargo. More than half of the shipments are cut flowers and other refrigerated goods (Table 1-6). Netherlands is a major recipient and Kenya a major exporter of cut flowers. Manufactured goods are shipped primarily from South Africa, which accounts for almost 1/3 of the northbound air cargo. The southbound trade, which has been the fastest growing, is primarily capital equipment, intermediate products and transport equipment. Together, these account for over half the shipments (Table 1-6).

Table 1-6. Commodities: African air cargo (%)

From	EU	Africa
To	Africa	EU
Capital Equipment	22	11
Intermediate Goods	21	7
Transport Equip.	13	
Refrigerated Goods		50
Primary Foods		6
Computers	7	
Consumer Goods	6	
Other	31	26

Source: Merge Global

Figure 1-10. Distribution of cargo in Africa
Tons loaded+unloaded at major airport



Source: Airports Council International

The air cargo is less concentrated than in Latin America. Three countries, Kenya, South Africa, and Egypt handle about half the air cargo (Figure 1-10). Africa has only three airports with significant cargo operations, Johannesburg, Nairobi and Lagos. [15] Johannesburg benefits from a strong local economy and a distance that makes air transport compulsory for most perishables exports to Europe. Nairobi has a relatively strong domestic demand for imports shipped by air as well as exports of cut flowers. It has leveraged this scale to become one of Africa's gateways. Nigeria benefits from the demand associated with its oil industry and other natural resources as well as relatively higher consumer demand. Cargo carriers have demonstrated an interest in serving this market despite problems with infrastructure and corruption. Other countries with significant potential for agricultural exports by air, for example Uganda and Ghana, have difficulties with landside access and transport services, especially cold chains.

South African Airways (SAA), Kenya Airways and Ethiopian Airways provide high quality air cargo services, often in collaboration with major international operators. However, most of the international gateways continue to rely on the traditional European carriers that operated during the colonial period.

[15] A fourth, Khartoum in the Sudan, had well in excess of 100,000 metric tons of air cargo but much of this is attributable to relief supplies flown under contract by commercial carriers and charter operators.

Europe accounts for more than half of the air shipments to the Middle East. The principal destinations are United Arab Emirates and Israel. Over half of the air cargo imports are capital equipment and intermediate materials for manufacturing, in particular equipment and spare parts for the petroleum industry, and transport equipment (Table 1-7). Other Middle East countries are increasing their imports as part of efforts to diversify their economies and improve their infrastructure. Westbound shipments to Europe include perishables, capital equipment and intermediate materials originating primarily in Israel. The amount shipped by other countries in the region is small but expected to experience significant grow as a result of diversification efforts.

Over half the air cargo handled in the Middle East moves through the United Arab Emirates reflecting its expanding demand for industrial products and consumer goods as well as its growing role as a transshipment hub for the region. Saudi Arabia, Bahrain and Israel together handle about a third of the air cargo (Figure 1-11). Bahrain acts as a transshipment hub primarily for DHL. Saudi Arabia has a large amount of imported goods for its petroleum industry and for domestic consumption. Israel is primarily an exporter of high value goods and perishables but also imports intermediate goods.

The largest airport is Dubai, which is among the top 20 cargo airports in the world. Its capacity is now being expanded through development of the Jebel Ali airport.

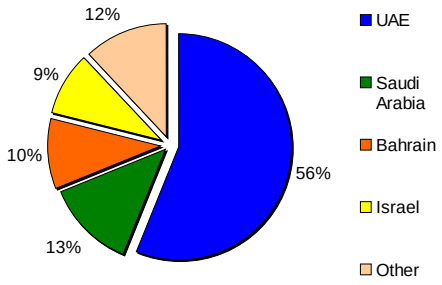
Table 1-7. Commodities: Middle East air cargo (%)

From	EU	Middle East
To	Middle East	EU
Capital Equipment	26	13
Intermediate Goods	23	14
Transport Equip.	6	
Refrigerated Foods		22
Primary Foods	7	
Consumer Goods	5	10
Other	33	41

Source: Merge Global

Figure 1-11. Distribution of cargo in Middle East

Tons loaded+unloaded at major airport



Source: Airports Council International

2 AIR CARGO SERVICES

The air cargo industry is comprised of companies operating under a variety of different arrangements. There are both "asset-based operators" which own and operate their own equipment and often contract supplemental capacity from other carriers, and "non asset-based" operators including freight forwarders who rely exclusively on equipment of other operators. The basic types of "asset based operators" are:

- combination carriers—passenger airlines offering cargo services,
- all-cargo airlines offering chartered and/or scheduled services,
- integrated carriers offering door-to-door services by combining air and land transport, and
- leasing companies providing aircraft on dry or wet lease.

Combination carriers

Combination carriers use passenger aircraft, combi-aircraft designed with additional freight capacity and, in some cases air freighters. They may limit their business to the carriage of express packages, mail, and palletized freight on scheduled passenger services or may operate their own cargo service with dedicated aircraft. Typically they are national carriers with a domestic hub-and-spoke system. They use their hubs as regional/continental gateways that feed into their international service and into interlining arrangements with other international carriers. They have the flexibility to shift from belly capacity to freighter capacity on routes with strong cargo demand, but otherwise offer the increased (often unique) frequency and coverage of their passenger network.

Seven of the ten largest cargo-carrying airlines are combination carriers (Table 2-1). These are primarily Asian carriers. Korean Air is the largest with about 8.7 billion freight ton-kilometers (FTK) flown in 2006. Two are European airlines including Lufthansa, the second largest, with 8.1 billion FTK, nearly all of which was international. Cathay Pacific is the fourth largest airfreight carrier with 7 billion FTK but has improved its market share through acquisition of Dragonair and a 20 percent stake in Air China. The largest North American combination carrier, Northwest, is 16th (Table A-3, Annex A), followed closely by American and United. Delta and Air Canada are smaller but still carry significant volumes. In Africa, only South African Airways ranks in the top 50 but Kenyan and Egyptian Airways also transport significant shares of the continent's air cargo. In Latin America, LanChile is the largest with a ranking of 30th, followed by Varig and TACA. In the Middle East, Emirates is the dominant carrier ranking 14th with Saudi Arabian, Qatar and El Al all ranking in the top 50.

Table 2-1. Ranking of scheduled air cargo airlines (million FTKs), 2006

Rank	Total		International		Domestic	
1	FedEx	15,145	Korean Air	8,680	FedEx	9,009
2	UPS	9,341	Lufthansa	8,077	UPS	5,315
3	Korean Air	8,764	Singapore Airlines	7,991	China Southern	1,027
4	Lufthansa	8,091	Cathay Pacific	6,914	Northwest Airlines	890
5	Singapore	7,991	FedEx	6,136	China Air	706
6	Cathay Pacific	6,914	China Airlines	6,099	China Eastern	560
7	China Airlines	6,099	Air France-KLM	5,864	American Airlines	493
8	Air France-KLM	5,868	Cargolux	5,237	Delta Airlines	452
9	Cargolux	5,237	EVA Air	5,160	United Airlines	417
10	Eva Air	5,160	Emirates Airline	5,027	ANA	404

Source: IATA

All-cargo airlines

All-cargo airlines operate scheduled services for contract shippers and may also provide charter operations for other airlines. The two largest scheduled all-cargo carriers are Cargolux based in Luxembourg, which operates a fleet of sixteen 747 freighters, and Martinair based in Amsterdam, which operates a fleet of 747, 767 and A320 freighters. They rank 11th and 17th respectively and together had almost 8.2 million FTK in 2005. Martinair was also part owner of Colombia's Tampa Airlines but recently sold their interest to the national carrier Avianca. Both Cargolux and Martinair utilize freight forwarders to arrange most of their shipments. Cargolux has a close relationship with Panalpina. These carriers have a significant presence in Africa and Latin America as well as the Middle East (Table 2-2). They operate in markets where there is limited competition from integrated and combination carriers. In order to overcome the problem of imbalanced flows, their scheduled services will often have multiple stops within a region (Figure 2-1).

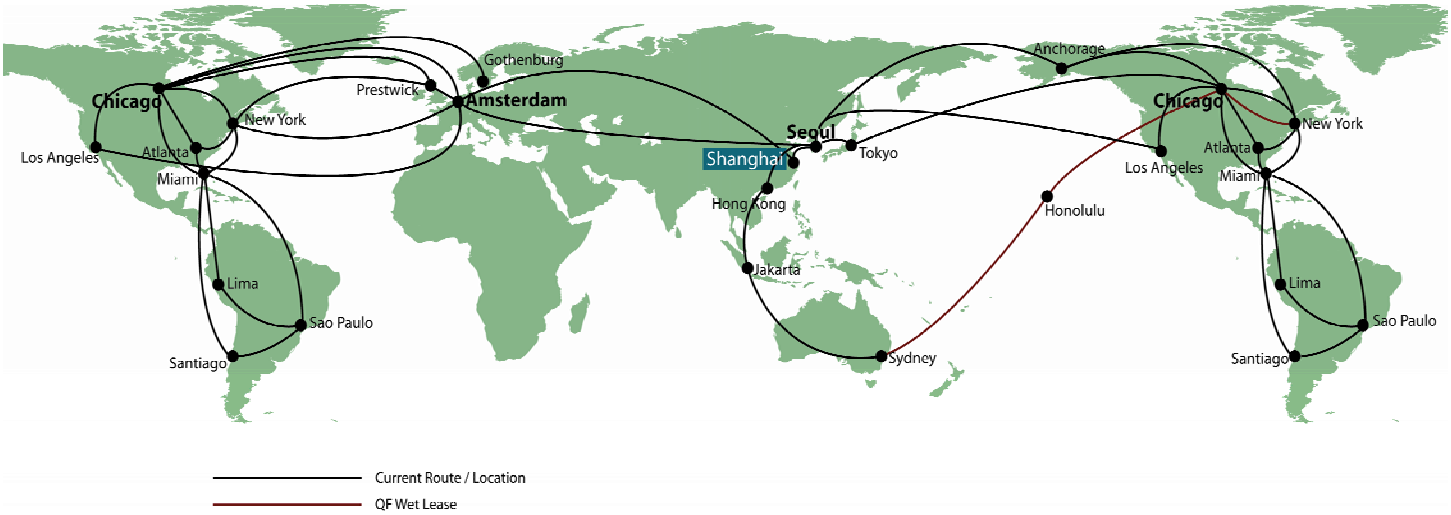
Other large all-cargo airlines providing scheduled services include North America-based Polar (part of AAWH [16]), Kalitta and ABX, and Asian-based Nippon Cargo, China Southern, and China Cargo.

Table 2-2. Destinations in Africa & Latin America for Martinair and Cargolux

	Martinair	Cargolux
Africa	Entebbe, Harare, Johannesburg, Khartoum, Kigali Nairobi	Abidjan Accra Eldoret, Kinshasa, Lagos, Lusaka, Johannesburg, Nairobi, N'Djamena
Latin America	Barranquilla Bogotá, Buenos Aires, Lima, Manaus. Mexico City, Quito, Santiago, San Jose, San Juan, Cali,	Bogotá, Curitiba, Latacunga, Petrolina, Santiago Sao Paulo

Source: Corporate websites

Figure 2-1. Polar air route plan, 2005



Source: Presentation "Air Cargo" by Ron Lane, Senior VP and Chief Marking Officer, Atlas Air Worldwide Holding, 30th Annual FAA Aviation Forecast Conference, March 2005

[16] Atlas Air Worldwide Holdings has a fleet of twenty 747-400 and twenty-two 747-200/300 air freighters.

Other all-cargo airlines charter out their freighters under a wet lease arrangement.[17] These include ICAR (International Cargo Airline), Atlas Air (also part of AAWH), CHI (now part of ABX), and Gemini Air Cargo. The latter serves clients such as FedEx Express, Air Canada, Avient and South African Airways. In 2005, CHI/ABX operated 91 freighters for DHL in the United States.

Integrators

The largest airfreight carriers are the integrated carriers FedEx and UPS, both of which rely on their domestic market for about 60 percent of their traffic. Other major integrators include DHL and TNT, but they have relatively small proprietary fleets.[18] All four rely on wet leases and other scheduled carriers to provide the additional air cargo capacity to serve their global networks. All four own and operate road transport, but again rely on third parties to provide the capacity needed for their global networks.[19]

FedEx ranked first in freight tonnage internationally, with 1.67 million tons. It had recently ordered ten A380s to strengthen its fleet capacity but may switch to Boeing 747s due to delays in delivery. UPS package volume has experienced strong growth benefiting from direct service between Shanghai and both U.S. and Europe. It had also placed an order for ten A380s and eight 747-400 freighters to expand its capacity. These operators have grown in recent years through a series of acquisitions. These were initially intended to extend regional coverage and to expand into land transport. Subsequently, they have been used to strengthen their retail network (Table 2-3).

Typically these carriers operate out of large regional hubs, which are interconnected by wide-bodied aircraft, and collect and distribute cargo through smaller national hubs connecting to their local truck network. Their networks were initially established in North America and Europe, then extended to East Asia (Figure 2-2) and more recently to the Middle East. These carriers have been more cautious in developing networks in Africa and Latin America, relying as much as possible on other carriers.

Table 2-3. Integrator acquisitions

Deutsche Post	FedEx	UPS	Deutsche Bahn	TNT
DHL	RPS	Emery	Schenkers	TG+ (Spain)
Danzas	American	Fritz	Bax Global	Mercúrio, (Brazil)
Airborne	Freightways	Menlo		Logistik (Turkey)
Exel	Flying Tigers	Mail Boxes		TEI (Thailand)
AEI	Kinkos			Wilson (Sweden)
Blue Dart (India)				Hoau Group (China)
Lemuir (Indian, JV)				
Staples				

Source: Ascend, Inc.

[17] ACMI - aircraft, crew, maintenance and insurance. The LESSOR provides the aircraft, one or more complete crews, and all maintenance for the aircraft and insurance for hull and third party liability for a period from one month to two years. The LESSOR charges for the block hour and may set a minimum guaranteed block hours limit per month. The LESSEE provides fuel, flight/navigation charges, landing/handling/parking/storage fees, crew, and other expenses.

[18] TNT continues to operate as a major integrator despite the sale of its logistics division to a private equity firm in 2006 and the sale of its freight management business to Geodis in the same year.

[19] The other large integrators have evolved from ocean transport, for example Maersk Logistics, APL Logistics and NYLK Logistics. So far, there has been little direct competition between these two groups.

Figure 2-2. DHL distribution network in China

Source: "Managing Risks and Safety of Business Travelers in China" by Wen Shan, Procurement Manager, DHL-Sinotrans International Air Courier Limited. Presentation given 8/22/07 at Asia-Pacific Education Conference 2007

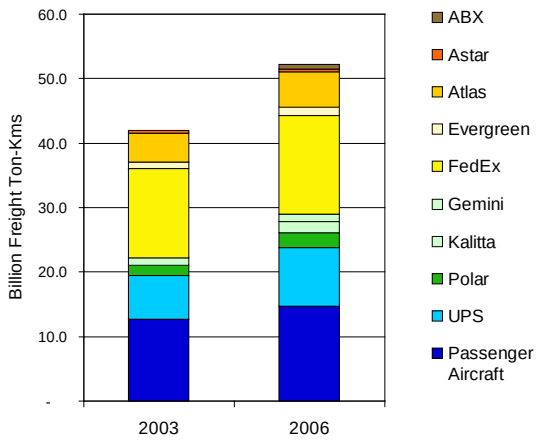
Historically, DHL has been more aggressive in expanding into developing markets but it also depends more upon other carriers' capacity. It has significant hubs for Latin America and Africa, in Panama and Lagos, respectively, whereas FedEx and UPS rely on hubs in the United States (Miami) for Latin America, and in Europe (Paris for FedEx and Cologne for UPS) for networking with carriers serving Africa.

With their origins in express services, the integrators have been responsible for raising the standard of reliability for air cargo shipments and in so doing have taken market share away from the passenger airlines' freight operations. They have introduced many of the innovations in third party logistics that facilitated the introduction of global outsourcing and just-in-time production. Their principal constraint on increasing direct services is the chronic imbalance of cargo flow which encourages the use of local carriers for the domestic leg and scheduled passenger services for the international leg.

Air cargo fleet

At present, a majority of the air cargo fleet (about 60 percent) is controlled by North American operators. Most is operated by all-cargo airlines, which account for most of the freight traffic (Figure 2-3). A substantial portion of their traffic is domestic. The international portion is divided almost equally between traffic with Asia and Europe/Middle East, but relatively little for Latin America.

Figure 2-3. U.S. carrier freight transport market shares

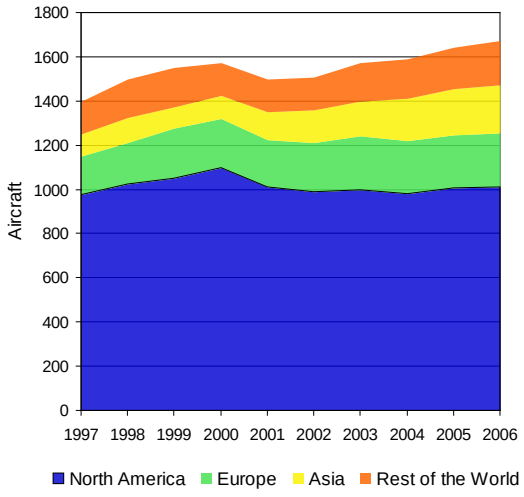


Source: Air Transport World

Despite strong and steady growth in international traffic, the total number of air freighters is increasing slowly. This is because average aircraft capacity is increasing as older aircraft are replaced. There is also a slow but steady shift in ownership. The fleets operated by Asia carriers are increasing rapidly (Figure 2-4) as are the fleets of Middle Eastern carriers. Most notable is the increase in the Chinese fleet. China Southern is the world's third-largest domestic cargo airline behind FedEx and UPS with about 1 billion domestic freight ton-kilometers flown in 2005. Air China and China Cargo Airlines also carry substantial volumes.

The air cargo operators generally have small fleets, with the notable exception of FedEx and UPS, as shown in Table A-3 (Annex A). In addition, they charter a large amount of aircraft. For example, UPS has about 210 of its own aircraft but charters more than 100 additional aircraft. The cargo airlines usually operate a mixed fleet of aircraft. The economies associated with operating a uniform fleet (in terms of manufacturer or aircraft) are less important for air freighters than for passenger aircraft and it is more important to match capacity with demand on the different routes.

Figure 2-4. Distribution of airfreighter fleet



Source: Ascend Inc.

Aircraft can be grouped according to capacity as follows:

- Below 25 tons: small narrow-body aircraft used primarily by integrated carriers and national airlines operating in regional markets. This includes Boeing 727s, 737s, and DC-9s.
- 25-40 tons: medium narrow-body aircraft used primarily by integrated carriers and combination carriers in regional markets. This includes Boeing 757s and DC-8s.
- 40-60 tons: small wide-body aircraft including Boeing 767s and Airbus A300s used by combination carriers.

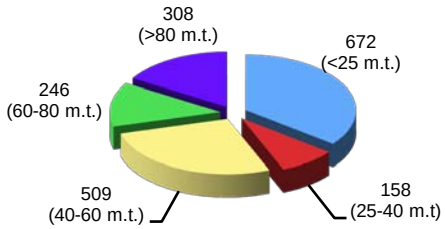
- 60-80 tons: medium wide-body aircraft including DC-10s and MD-11s used by integrated and all-cargo airlines.
- Above 80 tons: Large wide-body aircraft including Boeing 747s and the forthcoming Airbus A380 freighter used by integrated and all-cargo airlines.

The proportion of air freighters in each of these categories is shown in Figure 2-5. The average size of air freighters has been increasing steadily as most new aircraft are wide-body (Figure 2-6). In terms of current shares, over half of the air freighters are wide-body versus only about 20 percent for passenger aircraft. However, there are more than three times as many wide-body passenger aircraft as there are air freighters. In order to meet the future growth, the all-cargo airlines are expected to add capacity through a mix of larger aircraft that provide economies-of-scale on the major routes and mid-sized aircraft (100-ton not 150-ton) that provide direct services on regional routes. On the other hand, combination carriers are likely to take advantage of the belly capacity of their wide-bodied aircraft rather than acquire additional air freighters.

Because of the narrow margins in the airfreight business, operators tend to increase capacity both through acquisition of new air freighters and conversion of passenger aircraft (Figure 2-7). The latter involves purchasing used aircraft and adding large loading bays and freight floors. This is economical because air freighters operate fewer cycles per year. Since they are used less intensively and spend much of their time on the ground loading and unloading, their rate of fuel consumption is less important. Also, cargo aircraft do not need the modern systems, most of which are geared towards maximizing productivity of passenger aircraft. In the near term, it is estimated that about 70 percent of all freighter additions will be conversions of passenger aircraft. Most of these will be older aircraft (Figure 2-8, Table 2-4). Currently for large wide-body aircraft, the preferred conversion is 747-400. New purchases are focusing on the A380 and 747-8F. For medium wide-body aircraft, the most common conversions are MD-11, 767, and A310.

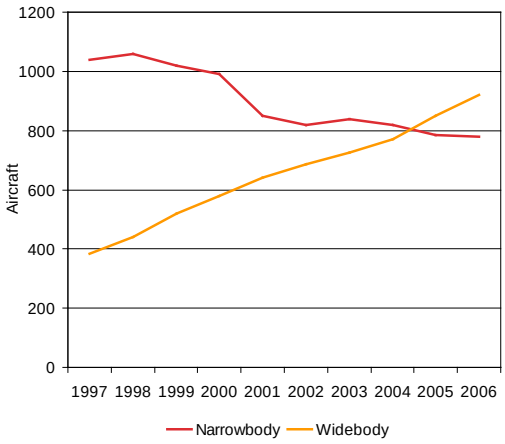
There are a number of challenges currently facing the airfreight business, of which the most important is rising fuel prices. Others include increasing competition from land-based courier services and ocean container express services. The role of air cargo consolidators is increasing creating additional competition with integrators for small

Figure 2-5. Distribution of airfreighters by capacity (m.t.)



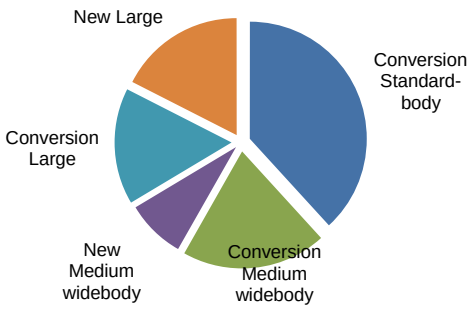
Source: Ascend Inc.

Figure 2-6. Freighter fleet by aircraft size



Source: Ascend Inc.

Figure 2-7. Source of new capacity

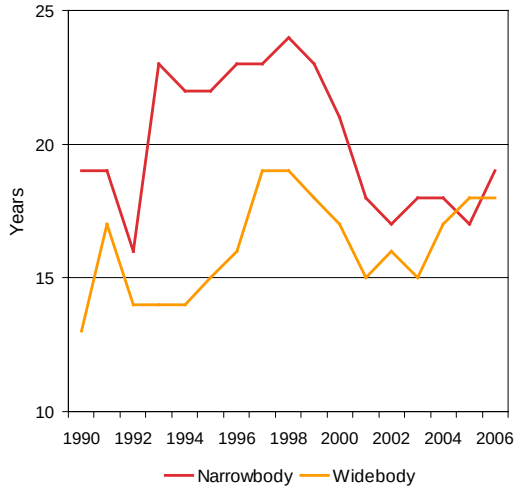


Source: Boeing

shipments. Furthermore, improvements in supply chain management reduce the demand for airfreight by minimizing the time for all activities in the supply chain. Also there is likely to be a slowdown in the outsourcing of production of higher value goods, which traditionally use airfreight.

While the problem of fuel costs is partially diminished through the addition of larger and newer (more fuel efficient) aircraft (See Chapter IV), the rapid run-up in fuel prices has put airfreight under significant competitive pressure. It has also given competitive advantage to the use of belly cargo on scheduled passenger aircraft. Although the marginal costs for fuel per ton of cargo are similar for the same models of air freighters and passenger aircraft, all-cargo airlines must price their services to cover the full cost of the aircraft and its operations whereas the passenger aircraft need only cover their marginal costs. Also, passenger aircraft are less vulnerable to downturns in economic activity, which can have a severe impact on all freight operations. The role of passenger airlines in the air cargo business is likely to increase as fuel prices increase, especially if growth in demand slows On the other hand, the increase in security requirements for air transport, especially passenger transport, is expected to discourage the use of passenger aircraft for airfreight in favor of all-cargo services.

Figure 2-8. Age of aircraft at conversion



Source: Ascend Inc

Table 2-4. Percentage of currently operating converted aircraft

DC-8	100%
B727/200A	30%
B747-200	34%
D 10-3	21%
A300 B4	40%
DC 10-10	45%
A310-200	57%

Source: Ascend, Inc.

For domestic airfreight, there will be increasing competition from land-based courier services as roadway infrastructure improves and long haul trucking becomes more common. It is expected that this will lead to a gradual reduction in the distance over which airfreight will have a competitive advantage for overnight and two-day shipments.

For international airfreight, there will be a parallel competition from ocean freight. Not only are the shipping times being reduced on the major routes but also improvements in supply chain management allow for better scheduling of production and permit longer transit times relative to the total order cycle. Part of this competition is likely to benefit sea-air operations as a way of reducing delivery times while avoiding the full cost of an airfreight movement.

While the average delivery times for both intermediate goods and final products have been steadily declining as manufacturers and retailers attempt to reduce inventories, this trend may be easing as the marginal cost for further reductions in inventory increases. The rising cost of airfreight will discourage its use to further reduce inventories. Also, the consumers' demand for decreasing delivery

times is expected to ease. On the other hand, the growth in Internet retailing is expected to generate additional demand for airfreight.

There is no doubt that the rapid growth in outsourcing of production to China has led to a dramatic increase in demand for international air and water transport. However, as competition from producers in the subcontinent—and to a less extent in Latin America—increases, there will be some shortening of average distance between sources of production and the markets for the goods produced. While this may lead to some reduction in market share for air cargo, the growth in trade will continue to be robust and support the steady growth in air traffic.

There is considerable fragmentation in the area of selling airfreight services with the shippers, forwarders, consolidators, and airlines all involved to some degree. The airlines themselves are also often represented by General Sales Agents. However, there is growing concentration in the market with the increasing importance of freight consolidation in order to reduce the cost of airfreight. This will encourage the use of all-cargo airlines and especially the integrated carriers because they provide their own freight forwarding, consolidation and delivery services.

3 AIRPORT CARGO OPERATIONS

Types of airports

Nearly all airports handle both cargo and passengers. There are relatively few pure cargo airports. For cargo operations, the airports can be categorized as hub and feeder airports, especially for international operations where the hub-and-spoke system continues to be the dominant operating model for scheduled flights, both passenger and cargo. Larger aircraft are used on long-haul international routes, while smaller aircraft serve domestic origins and destinations. This system allows shipments between origin/destination pairs that could not support direct, point-to-point, service. It also provides for more frequent services from the hubs to the various international origins and destinations.

The hub airport is generally located in or near a major population center to have a significant amount of inbound and outbound baseload cargo. It provides a transshipment node not only for interlining between domestic and international carriers but also for connections between an airline's domestic and international services. A larger hub airport may also act as regional gateway, for example:

- Hong Kong, which provides European and North American carriers with air and land access to China, as well as air access to other Asian destinations,
- Dubai, which provides connections between European and Asian services, also acts as a regional distribution center for Africa and the Middle East.
- Miami, Florida and Tocumen airport in Panama, which serve Latin American carriers connecting with North American and European carriers.

The hub and spoke system can also be intermodal providing a connection for sea-air services or for sea-road services. The latter involve RFS (road freight services) connections in which an international air movement is combined with a domestic road movement between the hub and feeder airport. The road transport segment is treated as a scheduled air shipment. The cargo is transported under an airway bill and customs clearance is performed at the feeder airport's warehouse. This arrangement allows an airfreight carrier to sell services to airports where it does not actually land. The latter can allow nearby airports to act as hubs for different carriers, as is the case with Dubai and Abu Dhabi or Beijing and Tianjin.

Most of the major hub airports serve either a large integrator or the dominant national carriers as shown in Table 3-1. However, some of the hub airports serve a broad mix of services, for example New York's JFK (Table 3-2). Governments can help airports to achieve the status by improving airport performance through investment in infrastructure and transfer of operations to private operators. Freight forwarders can promote the use of an airport for international

Table 3-1. Hub status of top 15 cargo airports

Rank	City	2006 Cargo (000 Tons)	Hub Status
1	Memphis	3,692	FedEx
2	Hong Kong	3,610	DHL
3	Anchorage,**	2,691	FedEx
4	Seoul	2,337	KAL
5	Tokyo	2,281	JAL
6	Shanghai	2,168	China Air
7	Paris	2,131	AF-KLM
8	Frankfurt	2,128	Lufthansa
9	Louisville	1,983	UPS
10	Singapore	1,932	Singapore
11	Los Angeles	1,907	Various
12	Miami	1,831	Various
13	Taipei	1,699	China Air, Eva Air
14	New York	1,636	Various
15	Amsterdam	1,567	AF-KLM, Martinair

Source: Airports Council International

shipments. However, the choice of hub airports remains the purview of the airlines, which choose hub airports in order to optimize their networks. Furthermore, multinational carriers do not have any local obligations beyond adhering to regulatory requirements.

Table 3-2. JFK airfreight carriers, 2004

Carrier	Tonnage
FedEx Express	189,978
American Airlines	157,223
Lufthansa	93,177
Korean Air	88,406
Asiana	61,416
Delta Air Lines	59,803
China Airlines	58,954
EVA Air	51,613
Polar Air Cargo	51,003
British Airways	49,597
Astar Air Cargo	49,107
Air France	46,380
Kalitta Air	44,261
Japan Airlines	42,113
Singapore Cargo	41,960

Source: Port Authority NJ&NY

The national hubs are usually airports that serve the capital or other major markets and act as a gateway to/from smaller markets within that country. The selection of national hub airports is often determined by government, especially where the national carrier is controlled by the government and required to provide essential air services to outlying markets that are not profitable. The national carrier either provides international services or interlines with a foreign carrier. In rare cases, this relationship can lead to the development of a regional hub but only where there is already a substantial and effective operation. For example, San Salvador evolved from a hub for the national carrier TACA to a regional hub once TACA established itself as Central America's regional carrier by acquiring the former national airlines of Costa Rica, Honduras, Guatemala and Nicaragua. As a regional hub, San Salvador provides shippers and travelers with direct flights to markets that would otherwise have only been served through interlining.

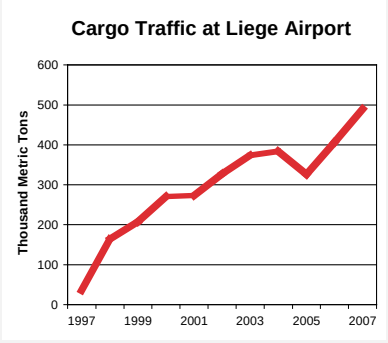
In recent years, the growth of large integrators has led to the development of airports in which cargo is the primary business. Since a certain scale of operations is required to justify the investment in an all-cargo airport (see discussion at end of chapter), there are relatively few of them and nearly all are located in the United States and Europe. These include FedEx regional hubs in Ft. Worth, Texas (Alliance Airport) and Columbus, Ohio (Rickenbacker), DHL's U.S. hubs in Riverside, California and Wilmington, Ohio and its UK hub at East Midlands. One of the few all-cargo airports in developing countries is Viracopos Airport in Brazil. There has been talk of setting up a facility in Johore in Malaysia but the profitability remains in question, especially given the proximity to Changi Airport in Singapore.

More common are airports in which there is some passenger traffic, but the cargo operations of the integrators are the major activity. Examples in the United States include the FedEx hub in Memphis, Tennessee, and Indianapolis, Indiana, the BAX Global hub in Toledo, Ohio and UPS' hubs in Louisville, Kentucky and Ontario, California. In Europe, there is the TNT hub in Liege in Belgium (see Box 3-1), and the DHL hub in Leipzig, Germany, as well as the Cargolux hub in Luxembourg Airport. There are no such hubs in Latin America, as the integrators prefer to operate out of Miami. There is, however, a major cargo operation in Bogotá, Colombia. In the Middle East, there are DHL hubs in Bahrain and Dubai. The latter also serves as the hub for FedEx, Emirates and most of the cargo airlines serving the region. In East Asia, FedEx and UPS have operated hubs at Subic and Clarke in the Philippines, but have since shifted their operations to China, Guangzhou and Shanghai Pudong, respectively.[20]

[20] There initial attraction had been their location on the main trade route to Southern China and Southeast Asia combined with very low charges and a liberal regulatory policy, but they lost this business when China liberalized its regulations.

Box 3-1. Liege Airport

Liege Airport is located within the triangle of Europe's major cargo airports—Paris, Frankfurt and Amsterdam. It was a military installation until 1990 when the Walloon government decided to concentrate cargo flights in Liege airport. A new airport company was established as a joint venture between Wallonia's regional airport company and airports authority for Paris. Five years after becoming a commercial venture, Israel Cargo Airlines (CAL) started using Liege, which now serves as its European hub for shipments of flowers, fruit and vegetables. The airport received a major boost when TNT established its regional hub there in 1997.



Liege is the 8th largest cargo airport in Europe handling about a half million tons. The cargo has grown steadily over the last decade despite a downturn in 2006.

The airport has a single 8,800 ft runway. It has 32,000 m² of warehousing, including a terminal for perishables, and seven B-747 freighter docks. It also has an 84-hectare cargo village with a 4-hectare transshipment yard for road and rail. More than 50 companies run cargo flights into the airport, including Emirates, Kalitta and Iceland Air, which flies fresh fish into Liege. China Southern Airlines has a code-sharing arrangement with TNT Airways, the airport's largest freight operator.

Source : http://www.liegeairport.com/

Another mechanism used to promote air cargo activities is the designation of an airport as a "tech stop." Initially, aircraft landing at the airport may refuel, make crew changes and possibly receive catering services but do not transfer cargo. The airlines select tech stops based on their position along the major air routes. Airports can compete for this business by offering attractive charges for fueling and provisions, attractive crew accommodations or aircraft maintenance facilities, but these are secondary considerations. In some instances, tech stops have evolved into hub operations as a result of strong growth in economic activity. The airports in the United Arab Emirates were initially tech-stops for flights between the Indian subcontinent and Europe, as well as between Southeast Asia and Europe. They evolved into regional distribution hubs as a result of the rapid economic development over the last 20 years. The situation in Anchorage is different. While it has relatively little economic activity, it was able to graduate from a tech stop to a transshipment point for flights between Asia and North America and between Asia and Europe over the North Pole. On the other hand, Dakar in Senegal remains a tech stop for flights between Southern Africa and North America while Almaty, Kazakhstan provides a similar service on connecting parts of Asia with Europe.

Other factors that affect the attractiveness of an airport for air cargo operations include the regulatory environments for international flights, the charges levied by the airport operators and national civil aviation authorities, the costs for cargo handling services, ability to contract third-party services, and airfield resources. While the latter is important, air freight carriers can adapt marginal or even

inadequate facilities by changing equipment, that is using less than optimal gauge aircraft where runways are too short and employing refrigerated containers at airports lacking refrigerated warehouses. The airport charges are important, but most airports set their aeronautical fees through comparison with other airports in the area. The costs for cargo handling remain a critical factor and depend on the level of competition permitted for on-airport services. Indeed, the ability of Subic Airport to convince FedEx to set up a hub there was based primarily on extremely attractive charges for the cargo handling facilities along with the autonomy to perform its own ground handling.[21]

Cargo handling operations

Cargo handling operations at airports involve the preparation of cargo shipments, the loading and unloading of the aircraft, and the transfer of cargo between the storage facilities and land transport. For outbound cargo, the preparation includes consolidation of cargo, building up of the air cargo pallets and containers, inspection and documentation. For inbound cargo, the preparation includes customs and other regulatory procedures, as well as deconsolidation. For transshipment cargo, the operation is generally limited to unloading, reconsolidating, and reloading the cargo but can be as simple as a direct transfer between aircraft (sometimes known as tail-to-tail transfer).

Although air cargo ideally remains in the airport for a relatively short time, it is necessary to provide storage facilities. Bonded facilities are required for imports and international transshipment cargo. For perishable cargoes, it is necessary to provide cold rooms. For outbound cargo, it is necessary to provide X-ray scanners to inspect the cargo. Since most air cargo is low density, most of the cargo is stored on racks, preferably in large open warehouses with high ceilings (more than eight meters). The storage areas must be equipped with loading docks on the landside to allow for rapid movement of goods to and from trucks. Most airports also provide offices near the warehouses for the airlines and forwarders to receive/deliver cargo and prepare shipping documents, and for customs to clear import and export cargo.

A major issue in the layout of airports is the extent to which cargo-handling activities take place on the airport versus outside the airport boundaries. The airlines receive and dispatch cargo on the airport. Inspection is generally done on the airport including scanning, which generally implies that the palettes are built up on the airport. Beyond that, exporters, importers and forwarders generally prefer to locate their activities outside the airport to avoid space limitations and reduce operating costs. Where possible, they also prefer to build their own pallets and ULD containers prior to delivery to airlines, especially where they have to maintain a cool/cold chain for temperature-sensitive perishables. However, this requires that pallets/containers be accepted “as is” without having to be broken down for inspection and then rebuilt. In order to do this, the airlines and security officials must certify the forwarder’s warehouse as well as the forwarder or shipper. Alternatively, if there is sufficient cargo volume, more expensive full pallet scanners can be introduced.

On-airport cargo terminals are usually multi-tenant. These may be common-user spaces managed by an authorized cargo handler, but, as traffic levels increase, carriers and integrators often want to have their own space. Initially this may be space rented on a long-term basis but eventually they need their own facilities. Similarly, forwarders/customs agents may occupy a designated storage area or merely place their customers’ consignments in a common area. In order to accommodate different carriers and consolidators, various airports have established cargo villages. These are sites with multiple cargo terminals. They usually evolve from the existing warehouse facilities, but in some cases are constructed on a new site. The village is designed to allow better coordination of operations and

[21] There was also the attraction of liberalized regulations allowing unrestricted service to other Asian destination.

improved traffic flow. It also allows for provision of a common office building to simplify the interaction between the carriers, forwarders and shippers. An alternative is to construct a larger, multi-story warehouse and lease space to the various parties. In the case of Dubai, both strategies have been applied with the introduction of a Mega Cargo Terminal within the Cargo village.

Different warehouse technologies are introduced as the volume increases (Table 3-3). The larger warehouses usually have more sophisticated equipment and layouts with the result that the throughput per square meter is also higher. These tend to be operated by integrators or third party consolidators who have sufficient volumes to justify the higher capital expenditure. The large integrators introduce automation because of their need to manage international supply chain, for example the DHL hub at Tocumen. Other parties that have sufficient cargo volumes to justify modern warehousing are national carriers and designated ground handlers with exclusive rights to provide on-airport cargo services. However, these groups are often inefficient monopolists not interested in making long-term investments to improve efficiency.

The area required for storage depends on the typical dwell time and stacking density. The large warehouses achieve higher throughput by better planning of storage and greater use of the available space. Although air cargo is low density, the dwell time is very short. Much of the cargo is cleared in a few hours. That which is not, rarely remains more than two days so that 75–100 turns per year is not unreasonable. With high stacks and narrow aisles, it is possible to achieve throughputs well in excess of 17 tons per year for a single integrator. With multiple tenants the number would be significantly lower.

The requirement for refrigerated space depends not only on the type of commodities shipped but the arrangement with shippers. Flower exporters are particularly intensive users of refrigerated space but usually locate their primary cargo handling and storage facilities off-airport. The flowers are transported to the airport just prior to loading the aircraft. This requires that there be no significant delays for security inspections and delays in aircraft movements. In Bogotá and Quito, there are refrigerated terminals on the airport but they operate independently of other cargo terminals.

Table 3-3. Characteristics of airport warehouses relative to throughput in tons

Annual throughput	Characteristics	Throughput per sq. mt
less than 50,000	less capital-intensive forklift operations; limited traceability and tracking of shipments; inefficient use of space and labor; higher losses from theft and misplacement and forklift operations	5
50,000-100,000	simple warehouse cargo management; requires slave pallets and equipment for their movements; racking of loose cargo; simple conveying lanes; marginal improvement in traceability; some reduction in loss rates	8
100,000-250,000.	semi-automated, efficient ULD/Cargo handling; traceability for location of shipments and containers/pallets; better use of space and labor	10
more than 250,000	Increasingly complete automation; significant investment in equipment and information systems; High performance standards	17

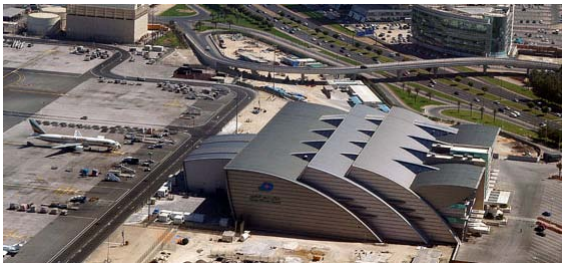
Nairobi has a pair of on-airport refrigerated storage facilities operated by the ground-handling subsidiary of Kenya Airways, as well as a stand-alone cold storage operated by DHL on the airport and Swissport off the airport. These are highly automated. Possibly the most advanced cold storage is the Dubai Flower Center, a multi-storey facility located next to the Dubai Cargo Village. It is designed for the storage and processing of flowers imported primarily from Africa for both the local market and for distribution to the region. The initial phase on this center is designed for an annual throughout of up to 180,000 tons of flowers (Figure 3-1).

The airport determines who can provide ground handling, both ramp and warehouse services. National carriers are often given exclusive rights to provide these services, especially in smaller airports. Other carriers or cargo handlers are usually reluctant to become involved unless they have substantial traffic to justify the investment and/or are allowed to offer the service to other carriers who would provide sufficient volume.

Alternatively, the government may give a third party exclusive right to provide these services. These are usually domestic companies but there is a growing number of international operators (Table 3-4). The latter provide not only special skills but also business connections with carriers and forwarders. They offer carriers a standard level of quality, but must organize themselves according to the regulatory environment in which they operate. For example, Menzies has expanded into Africa with ground-handling and cargo operations in Cotonou, Benin; Bangui, Central African Republic; Malabo, Equatorial Guinea; Accra, Ghana; Bissau, Guinea Bissau; Niamey, Niger; and Dakar, Senegal. These use partnerships in which independent handlers join the Menzies network, adopting its service standards and IT solutions. Swissport Cargo, which has eight operations in Africa and twenty in Latin America, utilizes joint ventures in which it holds a majority stake in Brazil, Philippines, South Africa, Kenya, Tanzania, and minority stakes in Algeria, Dominica, Peru and Honduras.

The development of on-airport cargo facilities can be undertaken by the airport operator or cargo handlers as part of providing services. More recently, real estate

Figure 3-1. Dubai Flower Center



Source: http://k53.pbase.com/o4/93/329493/1/63453330.etL6WfcR.LisbonMay06006.jpg

Table 3-4. International third party cargo handlers

Avia partner
Cargo Center
Menzies Aviation
Rhesus Air Handling
Swissport
Worldwide services

Box 3-2. Lynx-GECAS

GECAS is a major player in the aircraft finance and leasing sector, and has formed a joint venture with Lynxs Holdings, a real estate developer with investments in cargo facilities in various US airports as well as in Vienna and London. The company invests in airport warehousing, aircraft parking and ancillary logistics facilities. It develops these facilities and then sub-leases them to a cargo handler or airline (or combinations) for the period of the ground lease. This includes both new cargo facilities as well as refurbishment of existing warehouses. Its growth emphasis is on airports in developing economies like China and India where there is considerable potential for growth but the airport infrastructure is limited. Among the market factors that it considers in addition to the forecast of demand are the commercial activities in the airport's catchment area, the willingness of the airport to use third-party developers and the political and financial environment.

developers such as Aeroterm, AFCO, AMB and Lynxs-Gecas have begun developing airport logistics facilities for lease to the airport operators and ground handlers (see Box 3-2).

The challenge is to cultivate adequate competition to ensure efficient services. For small volumes, it is often left to the airport operators to provide the facilities and to assign responsibility for their operation to the national carrier and other tenants. For larger volumes, it is beneficial to have forwarders, carriers and/or third parties who invest in structures – either for their own exclusive use or to market their use to others. The use of contracted services and concessions can be an effective method for ensuring efficient and low-cost cargo handling services. However, the extent of competition depends on the volume of traffic and the area available on the airport. Modern airports tend to be much larger than their predecessors and include space for developing significant cargo operations. In some cases, this includes provision for areas to be used for distribution centers and processing of the goods, but the extent to which this is an efficient use of airport property depends on the airport's total land holdings.

Customs has an important role in the use of an airport for import cargo and more particularly for transshipment cargo. Because of the high value and time sensitivity of air cargo, it is important to minimize the time required for clearance of import cargo and to simplify the procedure involved in cargo transshipped through the airport. Many countries have developed a dual track for clearing goods. Expedited services are provided for express package services allowing them to meet tight delivery schedules, while large shipments are cleared more slowly. Most major airports in developing countries can clear cargo in a few hours to one day. While this is quite rapid relative to cargo shipped on other modes, anything over six hours must be considered inefficient and a reasonable target would be two hours. This is possible because of the level of computerization of airfreight documentation, which allows submission of the IGM (Inward General Manifest) at the time of departure from the previous airport. Slow clearance times are usually associated with the failure of customs and shippers to adopt modern information and communications technology. These systems are also important for tracking shipments and for ensuring efficient use of warehousing space.

Cargo airport economics

The opportunities for establishing a cargo-intensive airport are limited by economics. Without revenues from passenger flights, it is difficult to operate an existing airport much less develop a new airport. For example, an airport capable of supporting all-weather operations and handling wide-bodied aircraft would require a runway of 3,200-3,500 meters with a parallel taxiway, and air traffic control systems including ILS. The cost for the runway and taxiways is on the order of $100–200 million including earth moving but not land acquisition, which can be considerable since airports typically require at least 1,500 hectares, With a cost of capital of 10 percent and an annualized maintenance cost including renewals, of 1.5 percent=2 percent, of capital cost, the average cost for the airside infrastructure would be $13–27 million per year. Adding the costs for airside structures and equipment plus the basic terminal operations including traffic control, safety, security, and administration, a simple cargo airport would cost as least $15–32 million per year.

The revenues from aeronautical fees would be derived primarily from landing fees and parking fees. For a wide-bodied aircraft, these would be on the order of $2,000–3,000.[22] Assuming that the typical aircraft transfers an average of 50–70 tons per landing, this would amount to $30–60 per ton of cargo. In order to cover the basic airport costs, a minimum annual volume of about 0.5-1.0 million tons (60–120 aircraft movements per day) would be required. For an existing airport, which is

[22] "Airport Benchmarking Report", data for Asian airports

converted to cargo operations, the costs would be less. Assuming that the conversion cost is $^1/_4$ of the capital cost for a new airport, this implies a minimum annual volume of 175–400 thousand tons. In 2006, only 115 airports reported handling cargo volumes in excess of 150,000 tons.

For the same airport with a mix of passengers and freight, a large part of the airside cost would be covered from the aeronautical fees for scheduled passenger flights. Assuming an average of 120 passengers per aircraft movement[23] with slightly lower aeronautical fees reflecting the wider range of aircraft, a million passengers would generate $5.2-$6.5 million thereby covering 1/5–1/3 of the costs for a new airport but a majority of the costs for a converted airport.[24] In 2006, there were over 470 airports that handled in excess of 1 million passengers. While the operating costs for a passenger airport, which includes the passenger terminal and baggage handling systems, are much higher, these costs are usually covered by a combination of passenger charges and fees for parking and other concession.

While the economics of all-cargo airports are difficult, the principal impediment to the establishment of these airports is the economics of the airlines. The integrators are the only freight airlines with sufficient volumes to reach the scale of operations necessary to cover even the operating costs of the airport, let alone debt service, on the initial outlay. With the exception of Alliance, every one of their all-cargo airports was an underutilized brown-field, rather than green-field site. Also, all-cargo airports must capture sufficient domestic cargo. This typically requires participation of the national passenger airlines that carry the local cargo but are reluctant to use an all cargo airport offering less frequency and route diversity.

[23] op. cit.

[24] $2.000-$2.500 landing fees for 300 passengers (150 arriving and 150 departing) or $6.6-$8.3 per passenger.

4 OPERATING COSTS AND EFFICIENCY OF CARGO AIRCRAFT

The cost for air cargo operations is relatively complex and fluid because of four factors:

- Aircraft technology,
- Route characteristics,
- Structure of operations,
- Sensitivity to energy prices.

Cost structure

The principal components of the cost for air cargo transport are: the aircraft's capital and direct operating costs, the airport and navigation fees,[25] the ground handling charges and the cost for airline administration. The capital costs include depreciation and amortization for purchased aircraft and rentals for leased aircraft. The direct operating costs are primarily for fuel, maintenance, crew and insurance. The crew and insurance costs are fixed. The maintenance costs, which include routine maintenance as well as major overhauls for the airframe and engines, are variable. The schedules for maintenance and replacement of parts is linked either to flight cycles or hours of operation. For aircraft that are obtained through wet leases or charters, the rental costs include crew and maintenance.[26] The airport fees are primarily landing and parking fees. The ground handling costs include handling charges for the aircraft and cargo. The costs for administration depend on whether the airline is all-cargo or combination and whether it provides a scheduler or charter service or both.

These costs can be divided between exogenous costs, over which the carriers have little or no influence, for example fuel prices and airport charges, and endogenous costs, which the carrier can control through its procurement and operating procedures, for example capital, labor, and maintenance.

There are some economies of scale associated operating an aircraft, specifically the labor and maintenance costs. For air freighters, the crew size does not vary significantly with the aircraft size and for passenger aircraft, the cargo capacity has no influence on crew size. For maintenance, the costs increase with the size of the aircraft but not linearly. The cost for engine maintenance varies as much with the number of engines as with their size. On the other hand, the capital cost for both the airframe and engines increases in proportion to capacity as measured in terms of maximum take-off weight (MTOW). The cost of the engines is roughly linear relative to thrust, which is generally proportional MTOW. The weight of the airframe has remained a relatively constant proportion of the aircraft's MTOW, 0.5–0.6, in part because most airframes continue to be fabricated from aluminum.

[25] These fees are based on aircraft weight and, in the case of navigation fees, the length of the overflight over the country levying the fee

[26] A typical aircraft lease is a wet lease. The lessor provides the aircraft, one or more complete crews (flight deck, cabin attendants and engineers) including their salaries but not their daily allowances, all maintenance for the aircraft and insurance, which usually includes hull and third party liability. The lessee provides fuel, navigation and airport fees as well in-flight services, cargo insurance and in some cases, coverage for War Risk. The lessee is charged per block hour with a minimum guaranteed block hours limit per month. The period is usually one to two years. A "dry lease" does not include insurances, crew, maintenance and so on. It is generally utilized by leasing companies and banks rather than operators. A charter is the provision of air transport in which the schedule and use of the aircraft are specified for one or more movements and the provider is responsible for all operating costs.

The most important cost, that for fuel, does not have significant economies of scale because fuel consumption per kilometer is roughly proportional to the loaded weight of the aircraft as discussed below. Fuel consumption per FTK varies more with load factor and distance traveled than with capacity.

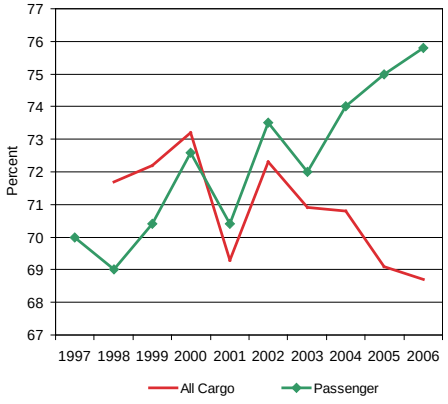
There is some variation in operating costs associated with the country of operation but this is relatively minor. The costs for crew and routine maintenance vary by country, but other costs are set through international competition. Because the number of crew on an air freighter is relatively small, the variation in labor costs for different regions has relatively little impact on total operating costs. The majority of the cost for aircraft maintenance is associated with major scheduled service including overhauls for both airframes and engines. These are performed by specially certified centers (MRO) located throughout the world. There is sufficient competition among these to minimize regional differences in cost. The costs for spares are set by the manufacturers and their licensed OEMs. The most important cost, fuel, is also relatively uniform throughout the world. There are some variations due to taxes and subsidizes (most notably in the Middle East) but these are generally short lived because aircraft operating on shorter hauls have a choice of where they obtain fuel. The more important variation is the change in jet fuel prices over time as discussed below.

The average unit cost per ton-kilometer for freight transport depends on the type of operation, the route and load factor. All cargo carriers offering scheduled and charter operations include both the capital and direct operating costs in their calculation of the costs for cargo transport whereas for passenger airlines, the transport costs for cargo carried as belly cargo is generally limited to the incremental cost for ground handling and fuel.

The length of the route affects the unit cost. Because of the time required for loading and unloading, air freighters generally perform only one or at most two flights per day. For shorter domestic and intraregional routes, this limits annual aircraft operating hours to 2000 hours or less, whereas for intercontinental routes the annual aircraft operating hours are typically 4000 hours or more. The result is variation in the unit costs per freight ton-km for capital and crew costs. There is also a variation in the fuel costs per kilometer, because of the fuel consumed per trip for taxiing, climbing, descending and waiting in holding patterns.

Load factor is important in determining average unit cost not only because there is a significant portion of fixed costs but more importantly because fuel consumption varies with the total weight of the aircraft. Since charter flights have higher load factors than scheduled air cargo services, they tend to have lower average unit costs for a similar number of operating hours. In the last few decades, the all-cargo airlines have provided both scheduled and charter services in order to maximize their fleet's load factor. During low periods on specific routes, the airlines reallocate aircraft between routes and between scheduled and charger services. They also employ a mix of owned and leased aircraft. Average load factors are typically between 68—73 percent but have been declining over the last decade (Figure 4-1) with the increase in proportion of scheduled services.

Figure 4-1. Load factor for international scheduled services



Source: IATA World Air Transport Statistics

Aircraft operating costs

Information on operating costs is available in different forms. The manufacturers provide data on operating costs but these do not reflect the costs incurred in actual operations. The U.S. DOT collects data actual operating costs from each of the airlines operating in the United States using Form 41. IATA, ATA and ICAO also collect data from member airlines. The U.S. data are compiled annually whereas the other organizations collect data when preparing special reports. The Form 41 reports the

Table 4-1. Information on aircraft operating costs from two sources

ICAO accounting	DOT Form 41
• Flight Operations • Flight Crew Salaries, Expenses and Training • Aircraft Fuel & Oil • Insurance & Uninsured losses • Lease/Rental of aircraft • Maintenance & Overhaul • Depreciation & Amortization • User Charges & Station Expenses • Landing & Airport Charges • Route facility charges • Station Expenses • Passenger Services • Ticketing, Sales & Promotion • General & Administration	• Operating Expenses – quarterly by fleet type – quarterly by function incl. Direct Operating Cost, Servicing costs, and so on. – by objective • Other Finance Related Data • Traffic Statistics • Employment • General Profit & Loss • Balance Sheet

airline costs by function including direct operating costs, ground handling, passenger-related services (in-flight, sales and reservations, airport processing), administration and marketing. The data is reported quarterly as shown in Table 16. However, most of the information is reported by the larger airlines that are involved primarily in passenger transport. As a result, significant portions of the costs refer to passenger services both on the ground and in flight. There is also the larger administrative overhead associated with passenger operations. As a result the direct operating cost account for only about half of the total airline costs (Figure 4-2).

The operating costs are also reported by aircraft in terms of fleet operating costs per hour along with the utilization in terms of hours per day and average flight distance. Again, the majority of this information refers to passenger operations for which the direct operating costs, including crew, fuel, maintenance and capital costs account for only about half of the total airline costs. Ground operations account for approximately 30 percent and general

Figure 4-2. U.S. airlines costs, 2006

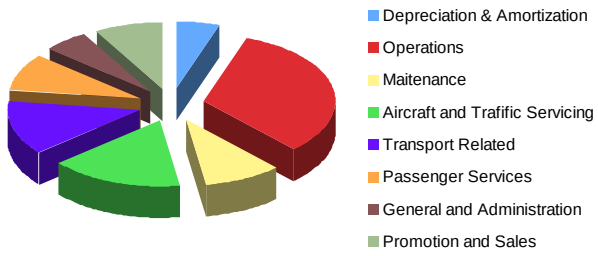
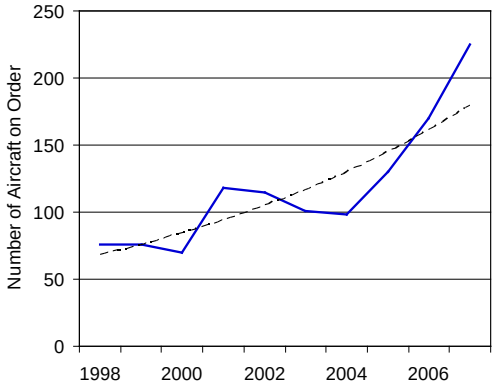


Figure 4-3. Airfreighter backlog



Source: Ascend, Inc

management and in-flight services accounting for the remainder.

The capital costs for air freighters are a relatively small part of total operating costs because of their age. The common practice of all-cargo airlines and combined carriers is to purchase used passenger aircraft and convert them by adding loading ramps. After 10 years of operation, the price of an aircraft will have decreased by at least 50 percent and after 15 years by 65—70 percent (Table 17). The integrators that offer express services prefer newer aircraft because they use them more intensively and can benefit from improved fuel efficiency. The current volume of new orders for air freighters is only about 200 compared with a fleet of 1,700. However, this number has been increasing. Since the majority of air freighters are 10 years or older, the fuel consumption and maintenance costs tend to be high relative to the capital costs as compared with passenger aircraft.

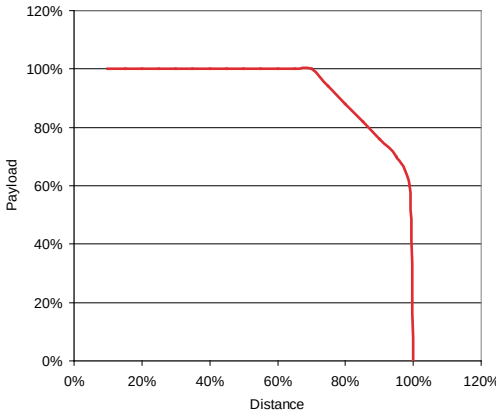
Table 4-2. Aircraft capital cost

	New*	Used Aircraft	
Aircraft	$mn	$mn	Age
B737-200		0.45-2.25	17-37
737-400	40,0	10.0-23.5	5-17
320-200	50-60	14.0-40.0	0-17
A300B4-200F		7.0-10.7	20-30
A300B4-600RF		37.0-68.0	1-12
B767-200F	50-60	7.0-10.5	19-22
B767-300F	110-120	50.0-80.0	0-10
DC8-70F		5.50-8.50	33-38
B757-200F		18.5-35.0	6-22
DC10-40F		4.0-5.5	22-33
MD-11F		40.0-63.0	4-14
B747-400F	180-200	76.0-145.0	0-12

** Source: Air Finance Journal, July 2007, Manufacturer's website, Avmark Inc. Report 2005 Author's estimates*

The average operating cost of an aircraft in flight is computed by dividing the direct operating costs plus capital costs by the number of hours of aircraft operation. The latter is computed in terms of block hours (the time from when the blocks or chocks are removed from the wheels of the aircraft prior to takeoff to when the blocks are placed on the wheels following landing). These costs include those incurred during taxiing, climbing, descending, and cruising at final altitude. Since there is a significant amount of fuel consumed while climbing and descending, the average fuel consumed per kilometer declines as the trip distance increases reaching an asymptote somewhere around 4-6 thousand kilometers. Trip distance also affects average block speed and therefore the fixed costs per kilometer. For short hops, block speeds average 500 kph; while for longer trips, they average 800 kph. For the extended range aircraft operating on the long international routes, the daily block hours can average 11-16 hours whereas for the short-haul market, daily block hours rarely exceed eight hours. As a result, aircraft employed on short routes have a relatively high cost per block hour with ground maneuvering, climbing and descending accounting for as much as ¼ - $^{1}/_{3}$ of the direct operating costs. For longer flights, this proportion drops to $^{1}/_{10}$ -$^{1}/_{7}$.

Figure 4-4. Trade-off of distance and payload



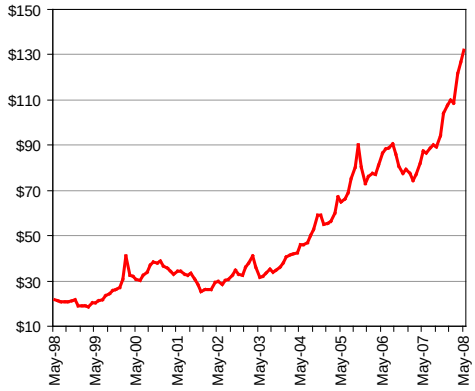
Source: ref. Peeters P.M.1, Middel J., and Hoolhorst A.

For the longer flights, the aircraft must carry additional fuel over longer distances, thereby reducing the payload and creating a tradeoff between payload and maximum range (Figure 4-4). There are also external factors affecting block hour costs such as airport

congestion, which introduces delays during taking off and landing, and weather en route, which can require detours thereby increasing route distance

An analysis conducted by ICAO in 2000 indicated operating costs per block hour for air freighters of $4,000–6,500 for larger wide-bodied aircraft, $2,500–3,500 for the smaller wide-bodied aircraft and $1,600–2,800 for the narrow bodied aircraft. The fuel costs accounted for 33–44 percent for the wide-bodied aircraft and 24–33 percent for the narrow-bodied aircraft. Since that time the fuel costs have increased by 150 percent as shown in Figure 4-5. At the same time, there has been a gradual increase in fuel efficiency, which has offset about 30 percent of this increase.

Figure 4-5. Average prices for jet fuel ($/barrel)



Source: ATA

An analysis of the 2006 operating costs was made using the U.S. DOT database for U.S. carriers. The costs included crew, fuel, maintenance and capital costs. After certain adjustments were made (Annex), the operating costs per block hour for different types of aircraft were as shown in Table 18. These indicate that the hourly rate is $11,000–12,500 for the larger wide-bodied aircraft versus $7,000–10,000 for the medium wide-bodied aircraft and $3,000–4,250 for the narrow bodied aircraft. The proportion of costs accounted for by fuel is 48–71 percent for wide-bodied aircraft and 32–47 percent for narrow-bodied aircraft.

Table 4-3. Estimated aircraft operating costs per block hour

	Fuel	Total Direct Op. Costs	% Fuel Cost	Operating Hours
B727-200/231A	4,086	12,095	34%	4,420
B737-200C	2,424	5,061	48%	913
B757-200	3,525	9,181	38%	5,602
B767-300/300ERr	4,747	8,815	54%	7,477
DC-9-40	5,045	11,484	44%	1,702
DC-10-30CF	7,526	14,086	53%	4,007
A300-600/R/CF/RCF	5,252	12,111	43%	5,604
A310-200C/F	5,108	14,848	34%	4,079
MD-11	7,343	15,139	49%	6,607
B747-100	10,983	16,406	67%	1,457
B747-200/300	10,076	15,295	66%	2,424
B747-400	8,899	13,838	64%	3,488
B747F	11,181	16,583	67%	5,726

Source: US DOT 41 - 2006

Adjustments: Fuel $0.75/liter, 5% increase in other costs

Fuel efficiency

As mentioned previously and discussed further in Annex 4, the fuel consumption of an aircraft is proportional to its loaded weight. Thus the consumption per additional ton of cargo is roughly constant. The fuel consumption per kilometer varies, because the aircraft must carry more fuel.[27] There have been significant improvements in fuel efficiency over the last thirty years due to improvements in aircraft technology, specifically airframe design and engine efficiency. Another round of efficiency improvements is in the process with the introduction of composite materials. However, the latter will have little impact on air cargo in the short run since most air freighters are older. Over the medium term, there will be a change in the composition of the air freighter fleet that will result in the larger, more economical, aircraft. However, without a dramatic increase in demand to spur acquisition of new capacity, the change will be slow.

Improvements in engine technology have reduced the consumption per unit of thrust. Most of these gains were been a result of the development of high-bypass ratio engines in the early 1970's. These reduce the fuel consumption per unit of thrust by allowing engines to be configured for long hauls with greater efficiency during cruising or for short hauls with greater efficiency during take-off and climb. Initially this was used to improve the propulsive efficiency for long haul, wide-body aircraft, resulting a noticeable drop in fuel consumption (Figure 4-6). Subsequently, in the 1980s, these types of engines were installed on smaller aircraft.

The changes in airframes included refinements in aerodynamics and improved trim, which reduced drag. The aerodynamic efficiencies of large aircraft have improved approximately 15 percent over the last quarter century through improved wing design and better integration of propulsion and airframe. These improvements reduced the coefficients for drag[28] as shown in Figure 4-7. The impact of these two improvements can be seen in the 20 percent reduction in fuel consumption for subsequent versions of the Boeing 747 (Table 4-4).

Improvements in fuel efficiency through reduction in the weight of the airframe are only now being introduced through the use of advanced materials. Lighter airframes reduce the required thrust and fuel consumption per unit of cargo capacity. It is estimated that a 1 percent reduction in the gross weight of an empty aircraft can reduce fuel consumption between 0.25–0.75 percent. So far, the use of advanced materials such as improved aluminum alloys and composites has been limited to control surfaces, flaps, and slats and the savings in weight have been more than offset by the added weight for improvements in aerodynamics and engines. More extensive use of composites is appearing in the newest aircraft as the increased cost for fuel offsets the higher cost for these materials. While this will have some effect on the integrators, which utilize newer aircraft, this will not have an impact on the all cargo airlines for another decade.

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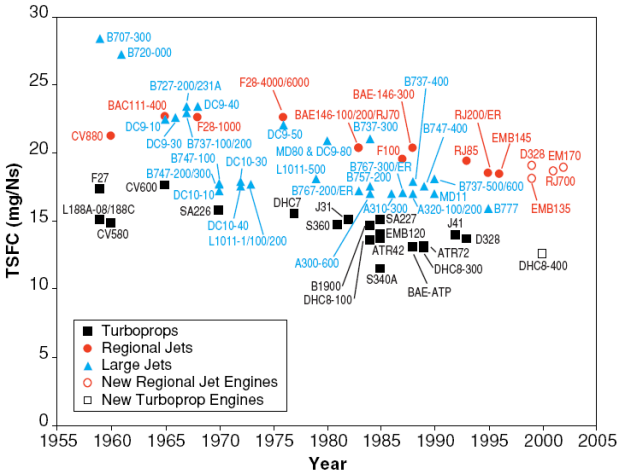
[27] Similarly, the more cargo that is carried, the more fuel that must be transported but this is a secondary effect.

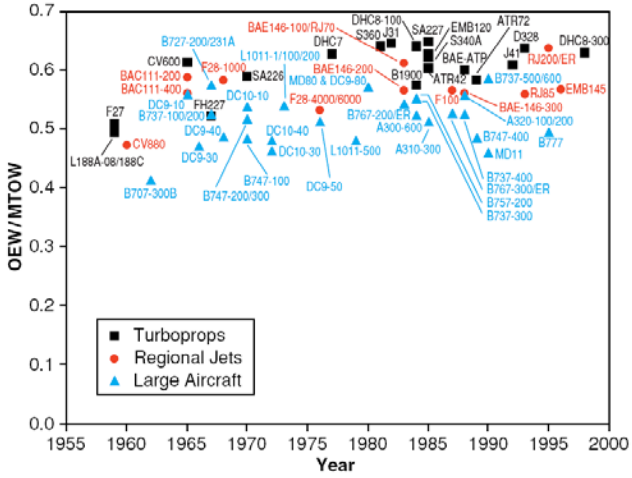
[28] Aircraft drag is the sum of zero-lift drag and induced drag due to lift. The former is the sum of drag due to skin friction and pressure. The skin friction occurs at the boundary layer as a result of the viscosity of the air and depends on whether the flow is laminar or turbulent. This drag depends on the shape of the airframe and the speed of travel. Pressure drag depends on the thickness of the boundary layer and its affects pressure recovery at the trailing edge. This is relatively small in subsonic flight. Drag due to lift has two components induced and viscous. The former is vortex drag depended on the distribution of lift across the span of an aircraft. The latter is due to the increase in the boundary layer with the angle of attack. At a given speed, the impact of aircraft weight on drag will occur because of the change in the wing to generate sufficient lift and the angle of attack of the aircraft. The marginal impact of cargo weight on drag is much less than the impact on lift. Thus for our purposes, the increase in thrust and thus increase in fuel required can be treated as a function of total aircraft weight.

Figure 4-6. Improvements in TSFC



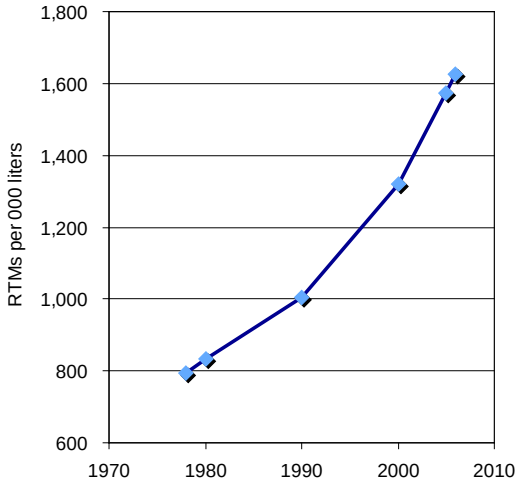
Source: Babikian, et al. MIT

Figure 4-7. Historical trends in L/D_{MAX}



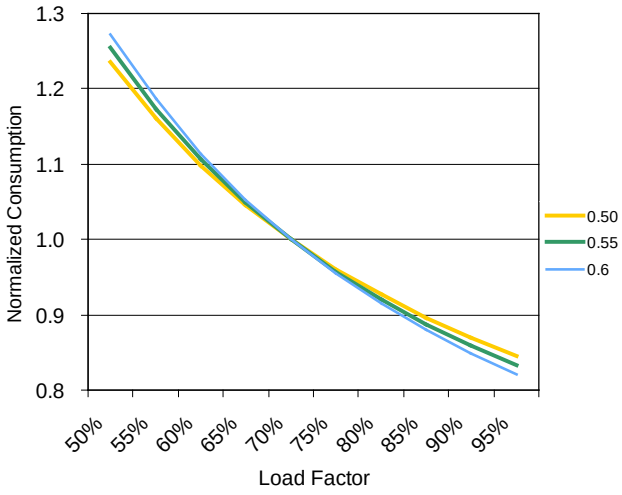
Source: Babikian, et al. MIT

Figure 4-8. Fuel efficiency



Source: ATA

Figure 4-9. Fuel efficiency vs. load factor



Source: Author's Estimates

In addition to improvements in aircraft, there have also been improvements in operations so as to reduce fuel consumption per unit of airfreight as measured in terms of revenue ton-kms. Over the last 30 years, these various factors have yielded a 50 percent reduction in fuel consumption as shown in Figure 4-8.

The cost of fuel is a significant part of the cost of airfreight. The fuel consumption at cruising speed is directly proportional to total aircraft weight for a given airframe and engine (Annex 4). For longer flights, it is also proportional to the distance. By implication,

Table 4-4. Boeing 747 average fuel efficiency

	Liters/Hr
B747-100	14,645
B747-200/300	13,434
B747-400	11,865

Source: US DOT 2006

the fuel consumption per ton-kilometer is constant and thus for a specific flight, the marginal fuel consumed per ton is constant.

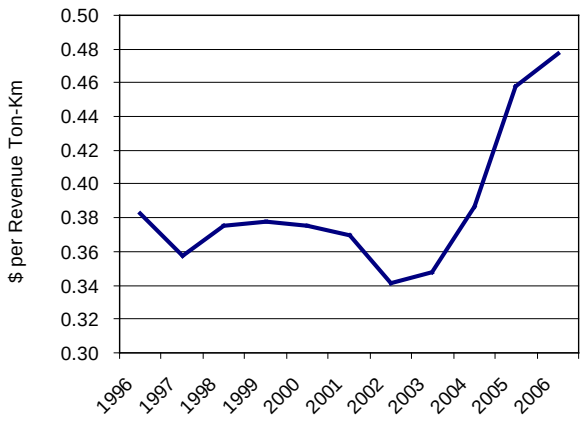
Since there are no significant economies of scale in fuel consumption associated with the size of air freighters, the principal technique for improving fuel efficiency is to increase the load factor. With an airframe weight equal to approximately 55 percent of maximum take-off weight, the increase in load factor from 60 to 90 percent will reduce fuel consumption per ton of cargo by about 20 percent. Figure 4-9 shows the relative change in fuel consumption versus load factor for different airframe weights (as a proportion of MTOW) assuming similar aircraft and engine design.

Pricing strategies

The pricing of air cargo is determined by market conditions. There are published guidelines, the Air Cargo Tariff or TACT, prepared by IATA based on regional meetings with its members. These are sometimes included in the bilateral air traffic agreements. However these rates are no longer enforced and apply only for small shipments or routes with relatively thin traffic. IATA members set their own rates often on a per shipment basis.

The structure of the pricing of air cargo services has changed as competition has increased. Freight All Kind (FAK) rates based on weight rather than commodity or cargo form began as an offering to large consolidators but have now become more commonplace as the market has grown more competitive. Volume discounts are used to attract business in general while specific commodity rates are used to develop specific markets. There are also class rates for commodities that require special handling, such as perishables and human remains.

Figure 4-10. Average unit revenue for U.S. airline cargo



Source: ATA Annual Report 2006

Discriminatory pricing continues to be used to improve margins based not on the cargo but rather the level of service. Increasingly, price is differentiated according to guaranteed delivery time, for example next day, 2–4 day, or one week. Faster deliveries are duly compensated with a premium. In some cases this includes provision of value-added services (Table 4-5), but in general it refers to the value added from faster delivery times. Slower deliveries are offered a discount because they allow the airlines to route cargo in a

Table 4-5. Differentiation of service levels, DHL

	Air First	Premium	Value
Time	fastest	3 days	economical
No weight or size restrictions	X	X	X
Clear transit time statement	X	X	X
Full shipment tracking visibility	X	X	X
E Quotation and e-Booking	X	X	X
Data transfer through EDIFACT	X	X	X
Express/ customs clearance	X		
Performance guarantee		X	
Freight unitized and sealed		X	X

Source: DHL Website

way that optimizes use of available capacity. Freight rates computed per kilometer taper off with distance in part because the block costs per kilometer decline and in part because the costs for cargo handling are fixed.

The pricing of air cargo has become contentious, as scheduled passenger flights often base their rates on the marginal cost of fuel whereas the all-cargo services base the price on the average unit operating cost of the aircraft. However, the lower price for belly cargo is offset by the uncertain availability of capacity, which varies with the quantity of passengers and luggage. All-cargo airlines compete by offering guaranteed capacity while integrators compete by offering faster, more predictable service.

The increase in operating costs has led to an increase in charges. This is reflected in the rapid rise in average unit rates charged for the U.S. airfreight business over the last two years, as shown in Figure 4-7. These relatively high unit rates reflect the dominance of higher rated express service for small shipments. The high unit revenues earned by FedEx contrast with normal intercontinental rates closer to $0.25 per ton-km for large shipment (Table 4-6).

Typical airfreight rates for major trade routes are shown in Table 4-7. These have increased with the fuel prices to the point that fuel surcharges sometimes exceed the base freight rate. In the short run, the rise in freight rates will be sustained by the increasing directional imbalances in international trade and an expected increase in the proportion of cargo transported on air freighters. The dominance of flows from Asia to North America and to Europe will continue to create/widen imbalances that will increase air transport costs. At the same time, an increasing share of Asian air export tonnage will flow through a limited number of Chinese gateway airports. This should create new opportunities for scheduled freight airlines to compete. The proportion of air cargo transported on widebody passenger aircraft is expected to decline, assuming passenger traffic continues to grow more slowly than airfreight.

The rising airfreight rates will encourage a modal shift for existing international cargo to sea and sea-air transport. This shift will be facilitated by improvements in supply chain management, which will continue to reduce overall delivery times, and the introduction of more express services by the large container shipping lines, which will reduce port-to-port transit times. In the medium term, increased fuel costs will be partially offset by the use of larger, more fuel-efficient aircraft. However, the market for airfreight will become more selective with air-cargo limited to the highest value and most time sensitive cargoes.

Table 4-6. U.S. airfreight carrier performance, 2006

	000's Departures	Traffic million RTK	Operating Revenues US$ mn	Rev/RTK US$
FedEx	377.0	16,964	22,068	1.30
UPS	153.4	10,088	4,571	0.45
ABX	55.7	919	1,260	1.37
Atlas/Polar		8,595	1,360	0.16
Evergreen Int'l		1,352	558	0.41
ASTAR		465	364	0.78

Source: ATA Annual Report 2007

Table 4-7. Typical freight rates

	$/kg
S. China- W. Europe	4.39
S. China-WCUS	4.62
S. China-Middle East	6.54
W. Europe-Middle East	2.01
ECUS-Middle East	2.00
W. Europe-E. Africa	3.45
W. Europe-W.Africa	6.44
China - C. Europe	8.85

Source: Freight Agents, excludes fuel surcharge which average $1.05 in May 2008

5 CASE STUDIES

As discussed in Chapter 1, there are four general categories of air freight: emergency cargo of spare parts, medicines, and so on, as well as courier shipments of documents and samples; high-value, low density shipments, for example gold, jewelry, currency, artworks, electronic components, fashion garments and luxury vehicles; perishable cargoes including seafood, fruits and vegetables, and cut flowers; and rapid replenishment shipments of consumer goods especially garments and inputs for JIT manufacturing. This chapter examines more specific examples of trade in perishables, garments and electronics, which are most relevant to developing countries. In addition, it considered some of the hybrid shipments that will end up being rush shipments and courier shipments.

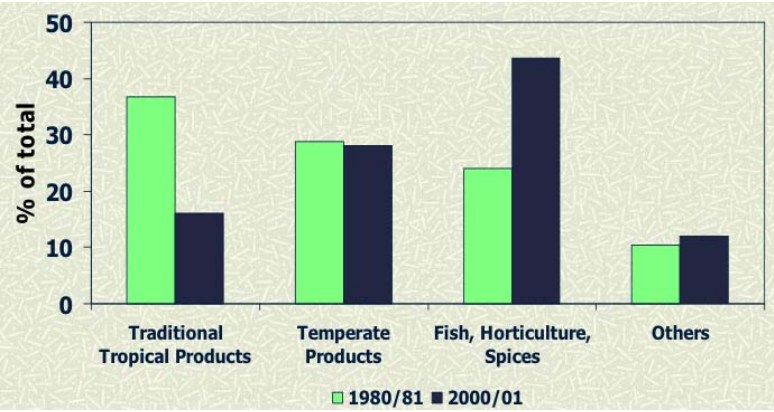
Trade in perishables

The composition of trade in fresh agro-food products has shifted towards horticultural products, fish, and spices (Figure 5-1), which has led to an increase in demand for airfreight to meet the delivery times. Growing fresh produce is not as scale-dependent as traditional agricultural export crops. While larger producers continue to have advantages in the introduction of new technology, maintenance of cool/cold chains and general logistics, small shareholders can often provide better performance in terms of traceability and environmental standards. They can also provide the additional attention required for growing the high value goods and produce the required volumes since the air shipments of high value goods tend to be a few tons.

Cut flowers

The supply of cut flowers to major markets in Europe and North America has shifted from the traditional sources in developed countries to lower cost producers in climates that allow continuous production without high-energy costs (see Box 5-1). This production has been concentrated in Colombia, Israel and Kenya, but new competitors such as Yunnan in China and Ecuador are increasing their market share. At the same time, new market destinations are being developed in East Asia and the Middle East. The traditional distribution channel, the Dutch flower auctions, are facing stiff competition from direct imports to EU countries, as well as competing auction markets being developed in Dubai and Kunming. As a result, the market appears to be going through significant restructuring.

Figure 5-1. Changing composition of agro-food exports



Source: High-Value Food Trade And Standards, Chicago, 2005

A critical element in the export of cut flowers is the management of the supply chain. From harvest to final delivery, the moisture and temperature must be controlled, as well as the overall transit time.[29] The quality of logistics is an essential element of competitive advantage. Cost is equally important and provides an advantage for countries that already have well-developed air freight routes, whether through scheduled freighters or space on passenger flights. The latter suggest synergies with a tourism-oriented economy.

Box 5-1. Evolution of cut flower market

In the 1960's, demand for cut flowers from consumers around the world was met by local production in both Europe and North America. In Europe, which has the largest per capita consumption in the world, about eight times that of the US, production was initially concentrated in the Netherlands. With expedited movements within the EU, it became possible to produce cut flowers in Southern Europe. The energy crisis in 1973 put producers in Netherlands and elsewhere in northern Europe under further competitive pressure because of the increase in cost for operating temperature-controlled greenhouses during the winter. The competition intensified when Israel began to sell cut flowers in the Dutch flower auction. Although further from the market, they could produce cut flowers throughout the year in open fields or plastic tunnels. In order to offset higher costs for transport to Europe and for water, the government provided transport subsidies and funded research on more efficient irrigation systems. Subsequently, African producers, especially from Kenya, entered the market often with production equipment and varieties from Israel.

In the US, production was initially concentrated near the major markets in the Northeast but with improvements in transport and cool chain technology, production shifted to California, Florida and Colorado where there were year-round growing conditions and lower labor costs. During the 1970's, the European flower industry operating through the Dutch flower auctions gained a share of the United States market through air shipments via New York. At the same time, Miami was developed as a distribution center for cut flowers from Colombia. South American cut flower growers purchased varieties from Europe while US growers purchased the more efficient European production systems. The Israeli flower industry also expanded into the US using New York and Miami as gateways. This significantly reduced the market share of the more costly American producers. Currently, California produces only about 15 percent of the flowers sold in the US. These are primarily varieties like sunflowers that are not easily shipped long distances.

The European flower industry has retained its position as a leader in commercial horticulture but this time through improvements in post-harvest handling and storage technology; marketing strategies; establishment of grades and standards; and development of transportation systems. In the 1980s, the European flower industry expanded into Asia supplying the growing consumer demand first in Japan and then in Korea, Taiwan, and Hong Kong. This was followed by sales to regional producers of flower varieties, production equipment, and technology for new production operations European flower traders also turned to Southeast Asia as a supplier of cut flowers but unlike Africa and South and Latin America, the production is not for Europe but for the regional market with its growing prosperity.

[29] After cutting, roses last 3 to 5 days, carnations 7 to 10 days, standard chrysanthemums 7 to 12 days, and pompon chrysanthemums 10 to 14 days.

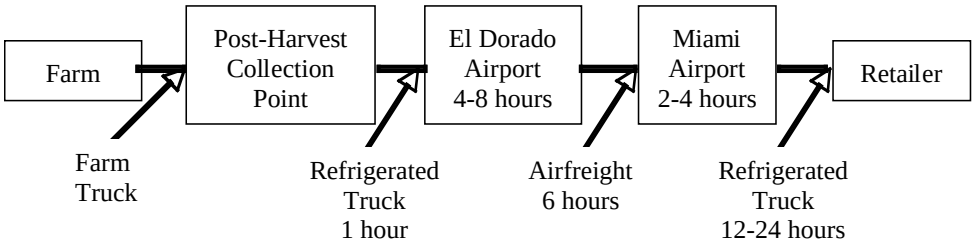
Colombia

Colombia's cut flower industry started in the early 1970s in the Sabana de Bogotá, which had a favorable environment, available fertile land and low labor costs. It began with the establishment of Florámerica, a flower exporting company formed by U.S. businessmen. There followed other firms involving Colombian entrepreneurs. By 1978, Colombia had captured 90 percent of the U.S. import market. In 2005, Colombia exported almost $1 billion of cut flowers, with the U.S. buying $742 million. Of the U.S. imports from Colombia, 40 percent are roses, 10 percent each carnations and chrysanthemums.[30] About 10 percent of the exports are shipped to Europe under GSP arrangements. The major markets other than the USA are Russia and Japan.

This rapid growth was accomplished despite difficulties with both the roads and airfreight services by taking advantage of trade preference schemes under the ATPA. Initially shipments were made as belly cargo on the scheduled flights of the national carrier, Avianca. However, Avianca's refused to make special provisions for this cargo and mixed the flowers with passenger luggage. The result was significant loss from heat while waiting for customs inspection and loading onto planes. This led to the introduction of a new carrier, Aerocosta, which though it eventually failed, raised the quality of service and caused Avianca to change its procedures and load the flowers at night. It also led to the introduction of scheduled air cargo services. Currently these include Martinair serving Europe and TAMPA, Arrow, Cielos de Peru and Lineas Aéreas Sudamerican serving the USA. For their part, the exporters acquired refrigerated trucks and provided a complete cold chain that uses the same U.S. distribution network as for flowers grown in Florida. The latter provided 2-day delivery to most East coast and Midwest destinations as shown in Figure 5-2.

Currently there are nearly 6000 hectares under cultivation on about 500 farms, selling cut flowers to over 300 exporters. About 75 percent of the flowers are grown in Bogotá – the remaining in Cali and Medellin. The most critical export route is Bogotá-Miami. Cut flowers account for about 84 percent of the approximately 0.25 million tons of airfreight from Colombia to the United States. At a current wholesale price of about $0.25 per stem, the value of a kilogram of roses (19 stems) would come to $4.75. Assuming an airfreight rate of about $1.30 per kilogram, this accounts for more than 1/4 of their wholesale price. The proportion is slightly higher for carnations, which have both a lower wholesale price and about twice the number of stems per kilogram.

Figure 5-2. Flow chart for Colombian flowers



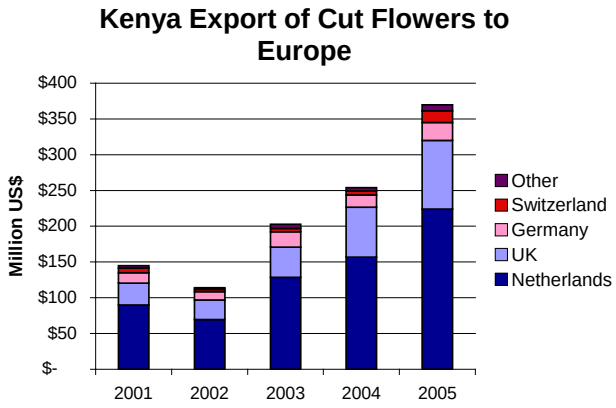
Source: Interviews

[30] According to the USDA Economic Research Service; http://www.ers.usda.gov/Briefing/Floriculture/Trade.htm

Kenya

Horticulture has been Kenya's fastest growing sector and is ranked third after tourism and tea as a foreign exchange earner. The country is the largest single supplier in the European flower market with a 31 percent market share. Its major competitors, Colombia, Ecuador, and Israel each have only about ½ this market share. About 69 percent of the exports are shipped to the wholesale markets in the Netherlands[31] where they are sold to the EU countries. While Dutch flower auctions have historically been the most important channel, changes in consumption patterns and supermarket supply chain rationalizations have lead to more direct contracts. Currently, about ¼ of the exports to Europe are sold directly to UK and Germany, as shown in Figure 5-3. Part of this is the result of a 2005 agreement with Germany to bypass the Dutch auction market.[32]

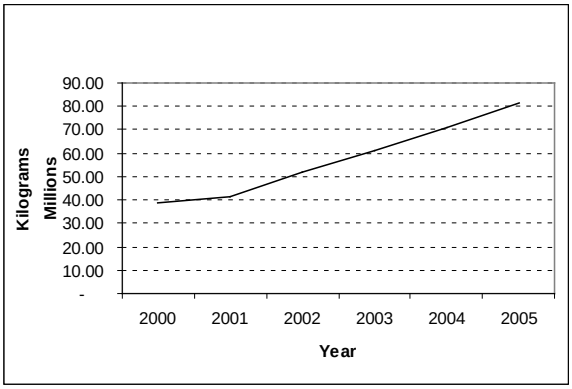
Figure 5-3. Kenya export of cut flowers to Europe



Source: International Trade Center

Kenya's competitive advantage derives from its climate, lower labor costs, less stringent environmental regulation, and lower trade barriers. Exports grew from about 3,000 tons in 1978 to 30,000 tons in 1998 and currently exceed 60,000 tons (Figure 5-4). The industry, which directly employs about ½ million workers,[33] is well organized. In 1996, the Kenya Flower Council was established to coordinate the efforts of independent growers and exporters and ensure implementation of acceptable local and international standards. Although there are now some 500 commercial flower growers, approximately 75 percent of the cut flower exports are produced by a few dozen large and medium producers.

Figure 5-4. Kilograms of flowers shipped from Kenya



Source: HCDA

About 3/4 of the flowers exported in 2005 were roses (Table 5-1). The average value of Kenya's cut flowers has varied and is now approaching $4 per kilogram, though there are wide variations. Demand for Kenyan flowers in Europe is still experiencing strong growth even while the delivered price has been increasing (Figure 5-5). This has

[31] Though Kenya supplies directly to markets in the UK and other countries, shipments to the Netherlands may appear elsewhere – Dutch flower auction houses present the largest flower market in the world.

[32] This auction, which has existed since the early 1900s, acts as a grower's cooperative, obliging growers to sell all of their production through the auction.

[33] http://environment.guardian.co.uk/conservation/story/0,,2012674,00.html

encouraged new entrants including Rwanda, and Uganda. The latter has not only rich and fertile soil but also sufficient cargo capacity utilizing both passenger and freighter services (DAS Cargo).

Cut flower exports began in the late 1960's when wide-bodied jets were introduced to transport tourists and the airlines offered the additional cargo capacity to the fresh produce industry. Currently, over 90 percent of fresh horticultural products are air freighted, which makes securing air cargo space a priority. Large exporters have been able to exercise some control over space through joint ventures with freight forwarders. As much as 90 percent of the shipments to the U.K. are carried as belly cargo on Kenyan Airways. Air cargo carriers, such as Lufthansa Cargo and Cargolux, provide dedicated cargo space from Nairobi to Frankfurt and Maastricht.

An estimated 70 percent of the flowers are grown at the rim of Lake Naivasha, northwest of Nairobi. [34] There are good road network connections between the Lake Naivasha growing area and Nairobi's Jomo Kenyatta International Airport, a distance of about 80-100 kilometers. [35] Flowers picked in the morning reach markets in Amsterdam by evening.

Ecuador

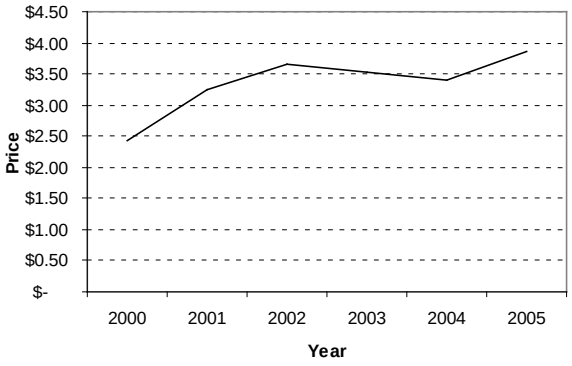
Ecuador's flower production covers over 2,000 hectares. It has the advantages of a variety of climates and geography, which ranges from the low coastal highlands to the high Andes (Sierra) plus the lower tropical Oriente and Amazon areas. There are around 60 varieties of roses grown for export. To improve competitiveness, there is a program of diversification from roses

Table 5-1. Kenya's principal greenhouse exports, 2005

Commodity	US$ million	Amount million ton	Value US$ per kg
Roses	199.0	61,072	3.26
Mixed Flowers	29.0	7,043	4.12
Carnations, Std	9.7	2,603	3.73
Cuttings	9.1	469	19.33
Hypericum	5.9	1,781	3.33
Lisianthus	4.6	408	11.25
Carn. Cutting unroot	3.5	171	20.62
Gypsophilla	3.2	793	4.01

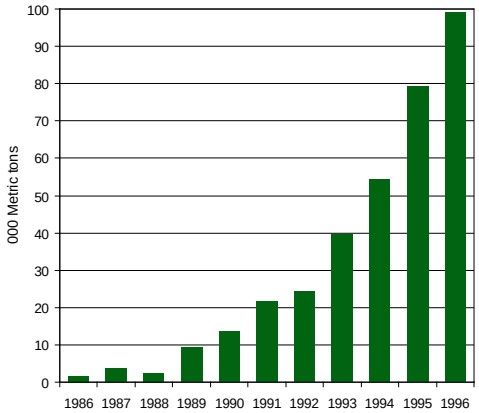
Source: HCDA

Figure 5-5. Average value per kg of Kenya's cut flowers



Source: HCDA, Year End Exchange Rates

Figure 5-6. Growth in Ecuador flower export



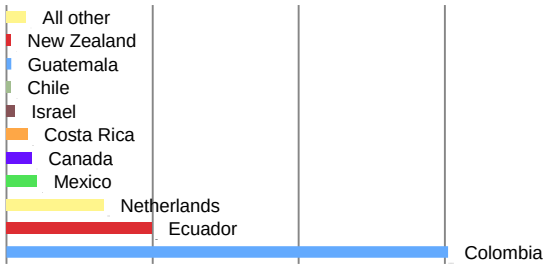
Source: Prepared by: Corporación Financiera Nacional, Strategic Planning Division, 1997

[34] An excellent draft paper summarizing the Kenyan flower industry can be found in Knowledge, Technology and Growth: The Case Study of Lake Naivasha Cut Flower Cluster in Kenya, April 2006, by Maurice Bolo of the World Bank Institute.

[35] Distance as measured via Google Earth is 82 kilometers straight line, 100 kilometers following road.

to other profitable ornamental flowers: Gypsophila ("Baby's Breath"), Limonium and Liatris species, as well as "Summer bloomers".

Figure 5-7. U.S. imports of cut flowers by value, 2001



Source: U.S. Department of Commerce

The most rapid growth in exports occurred in the period from 1986–1997, as shown in Figure 5-6. Currently, it is the second largest exporter of cut flowers to the United States (Figure 5-7). The flower industry consists of 250 companies employing about 60,000. The volume of air shipments is about 80,000 tons of flowers, worth $300 million. Because of limited airfreight options, transport from Ecuador is about 60 percent more costly than for Colombia or Peru. Some reduction is expected with the construction of the new 11,000 square-meter cargo terminal. Over the next decade, a growth rate of 6 percent is expected.

Cut roses are put in bunches of stems and packed 10 bunches per box for shipping. Other flowers are shipped in boxes containing on average 35 bunches, consisting of 20 to 25 stems each. Also grown are chrysanthemums. About 25 ten-stem bunches are put into each box. The principal export destinations are the United States, Italy, Russia, Germany and Canada. Lesser quantities are shipped to Argentina, Switzerland, Spain and France with most shipped by air.

Yunnan

Yunnan has a wide range of different microclimates that support some 2,500 types of rare ornamental flowers and trees. The capital city of Kunming and nearby Yuxi city are the centers for horticulture. They produce subtropical cut flowers, while southern Yunnan produces tropical orchids and indoor foliage plants. Although the province has a long history of growing flowers, commercial production of cut flowers only began in late 1988 when a village switched to flowers when prices for its traditional vegetables declined.[36] Within five years, it had become a center for production and the wholesale of cut flowers. Over ten years, the area cultivated in cut flowers increased to 1,700 hectares. By 2003, there were over a hundred enterprises that had 3 or more hectares under cultivation and currently the total area exceeds 5,000 hectares with about $100 million in production. There were a significant number of joint ventures with companies from Hong Kong, Taiwan, Japan and the USA, as well as substantial investments by Dutch horticultural companies.

The flowers are sold either directly by growers or through traders who purchase flowers at the wholesale flower market and sell them through commissioned agents, local wholesale market or retailers. Approximately 55 percent are sold through the wholesale market in Dounan Village where there are nearly 400 traders and daily volumes during the peak season exceeds 4 million stems. Only a few large enterprises and farmers sell to wholesalers outside the province or to foreign buyers directly.

The province provides about half of China's total cut flower production. Of this, 80 percent of the volume is sold to within China. The rest is exported primarily to Asia. In 2003, the total exports were

[36] A tobacco grower in Yunnan earns an average of RMB 16 thousand per ha. a vegetable farmer RMB 64 thousand, and a flower grower RMB 240 thousand.

valued at $30 million. Although production is projected to reach about $250 million in 15 years, exports are not expected to increase significantly. The exports are primarily roses because they have a high value per pound and are easy to transport long distances with limited damage. However exports have been constrained by disputes over the evasion of royalty payments.[37] Other flowers are less attractive for exports. Carnations can withstand air shipment but have a low value per pound. Tulips have a high value but must be packed very loosely and are therefore costly to ship.

With no direct flight from Kunming to the international cut-flower distribution centers, guaranteeing the essential “cool chain” is a major problem. Inadequate capacity of air transport and high airfreight rates as well as difficult export licensing and high fees for quarantine and customs create additional problems. Opportunities for expanding production of cut flowers in Asia require improvements in post-harvest handling, storage technology, transport, grades and standards and marketing strategies for the unique demands of Asian market.

Most of the flowers are exported to Japan, South Korea, Hong Kong and Thailand, since they are relatively near, and requirements in terms of post-harvest storage are minimal. However, most of the shipments to Bangkok and Hong Kong are re-exported to other Asian countries, to Russia, the Middle East, Europe, and to a limited extent to the United States. The cost of air shipping works out to about 30 cents per long-stemmed rose. By comparison, farms in Yunnan sell their flowers at wholesale for $0.04 to $0.16 cents apiece, ($0.28 each just before Valentine’s Day).

Fruits and vegetables

In the late 1980s and early 1990s, high-value agricultural exports were typically produced by smallholders and exported by locally owned companies to independent importers in Europe. Since then, the evolution of supermarket and large retail chains, such as Royal Ahold, Carrefour and Wal-Mart, caused increasing consolidation among exporters in order to meet the demands for quantity and consistency. Also these chains working through their major distributors extended their role in the supply chains connecting directly to growers in order to ensure greater consistency in quality. They improved storage, cooling and field-to-packing plant logistics so as meet the higher standards for SPS, traceability and social compliance.[38] This also allowed a shift to table-ready products such as mixed salads that required that ingredients be picked, prepared, fully-labeled and transported to the supermarket shelves within 48 hours. For their part, the exporters sought to differentiate themselves through value-added processing (pre-preparation and pre-packing) as well as developing products that involve more complex handling, for example "baby" vegetables and fruits.

The demand for fresh produce led to increased investment in post-harvest processing and cool/cold chains, which places increasing emphasis on the role of the packinghouses or consolidation facilities for smallholder production. These various factors, together with higher product standards and traceability requirements, led to simpler, more integrated supply chains for which airfreight is well suited.

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[37] Growers in Yunnan have produced a few new varieties and registered them with Chinese authorities. They have made few efforts to register them abroad, because they would be subject to questions about whether the new varieties are derived from ones that are already registered, in which case royalties would be owed.

[38] Public grades and standards are being overtaken by the private grades and standards imposed by the large supermarkets and processors, which introduce sophisticated quality assurance systems to document seed procurement, planting schedules, agrochemical and fertilizer use/storage, personal hygiene practices, and so on.

Kenya has a well-established trade in fruit and vegetable. It has a strong trade in off-season vegetables such as peppers, especially to the UK and all-season exports of green beans and specialty Asian vegetables to the EU. Exports grew at 9 percent per year in the first decade following independence, then at 17 percent per year from 1974-1983 but then slowed to about 4 percent during the 1980s and 1990s. In 2003, exports totaled $260 million, or 15 percent of Kenya's total exports.

In recent years, there has been increasing competition for the market for tropical and sub-tropical fruits in Europe and the Middle East from suppliers in North Africa, especially Egypt and Morocco. Most of their exports are shipped by ocean with shorter transit times than Kenya. Because of difficulties in organizing timely shipments by sea, has been unable to secure a significant share of this market. Even in its traditional trade in green beans, exports from Morocco, Egypt, Senegal and Zambia have gained market share. All but Zambia have lower freight rates, either by air which is about $0.75/kg for Morocco or sea which is about $0.20/kg for Egypt. Since Kenya already enjoys highly competitive airfreight services, the competitive situation in unlikely to change.

In order to improve margins, Kenya has focused on UK markets, where there is less competition from North African suppliers. It also sought to maintain competitive advantage by focusing on products that have higher standards, SPS and others, by increasing variety and product differentiation, and by shipping direct to the major supermarket chains. This meant introducing a wide range of chilled, prepared food products and a diversity of fruits and vegetables. It also meant exporting vegetables as higher value products including mixed salads and cut vegetables for stir-fry mixes. This value-added processing contrasts with fruits and cut-flower export sectors, which have relatively little processing other than grading, packing, and labeling.

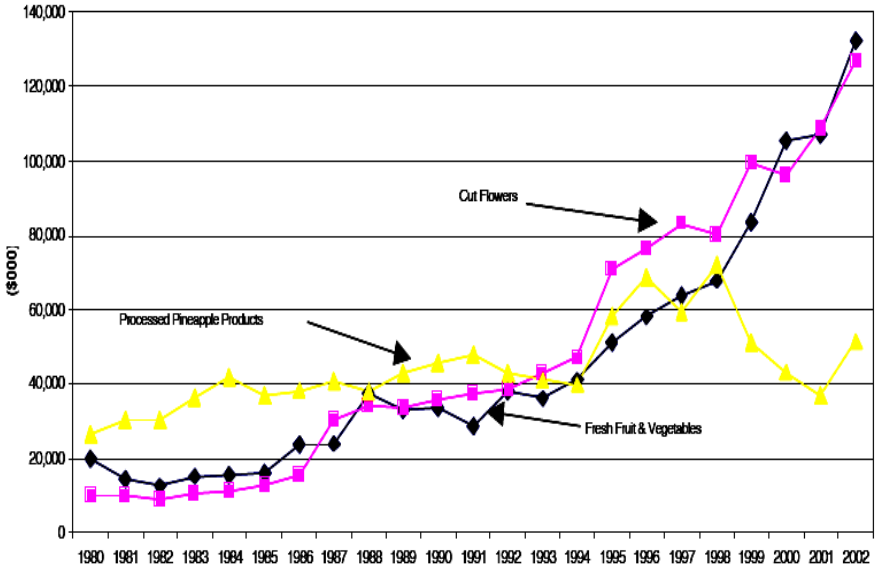
This resulted in a change from trading operations to integrated food processing.[39] This required investments in facilities and systems to produce higher value pre-packed produce. The top five exporters in Kenya now control more than ¾ of fresh vegetable shipments. Kenya's largest horticultural exporter, Homegrown, is vertically integrated with 90 percent of its crops grown on its own farms. It controls the logistics from farm to market including the packing plant, airfreight (through a joint venture) and a dedicated distributor based in the UK. It has recently completed a factory for prepared salads.

These strategies tripled the average FOB value of Kenya's vegetable exports (2003 $2.9 per kg versus 1993 $1.0 per kg). They also shortened shelf life requiring a dramatic increase in the use of airfreight. By specializing in premium end of the market, the proportion of costs associated with transport has declined. By combining the processed fresh vegetables with the higher value beans, Kenyan exporters were able to get better airfreight rates. The cost of airfreight for green beans and Asian vegetables from Kenya to European market is between $1.50 and $1.60/kg.

Kenya's development has been enhanced by an open and competitive market for airfreight, duty free inputs and outputs, and liberalized foreign exchange markets. Kenyan Airways is important in maintaining competitiveness because other carriers operating in North Africa, most notably Egypt Air, have spare capacity on the northbound routes and can offer lower airfreight rates.

[39] The remaining option for improving competitiveness is improving the logistics associated with retailing but this is unlikely since a major of the exports are already sold direct to large food chains.

Figure 5-8. Kenya horticultural/floricultural exports by product category



Source: From Challenge to Opportunity, IBRD

Fish Exports

Exports of seafood have many of the competitive affecting air transport of perishables. The first is the improvements in freezing technology, which has led to a redefinition of what is fresh fish. The second is improvements in cold chains including refrigerated containers, which allow shipment of frozen goods by ocean without deterioration. The third is the competition for smaller airfreight shipments of fresh seafood between scheduled air freighter services and passenger services which offer services to the final destinations but with transfer through hub airports.

The trade in seafood has changed significantly with the development of cold chains from boat to processing plant, freezer and then refrigerated containers. Improved techniques for freezing seafood allows processing plants to prepare the seafood in a form that is ready for display at the supermarkets and also ready for cooking. These changes have allowed exporters to extend their markets for frozen fish, which continues to be shipped by sea because of price competition. Airfreight is used primarily for fresh seafood (chilled or live). For these, perishability requires less than one day from the processing plant to the wholesale market and another day to the restaurant or dinner table. The major markets for fresh fish are the OECD countries. Because of the short transit times, Latin America is the main supplier for North America; Africa and the Middle East are the principal sources for the EU countries; and Southeast Asia is the primary source for Japan and Korea. Some longer supply chains have been introduced as a result of the introduction of long-haul flights between Asia and Europe and North America. These supply restaurants, which have become major buyers of the more “exotic” species.

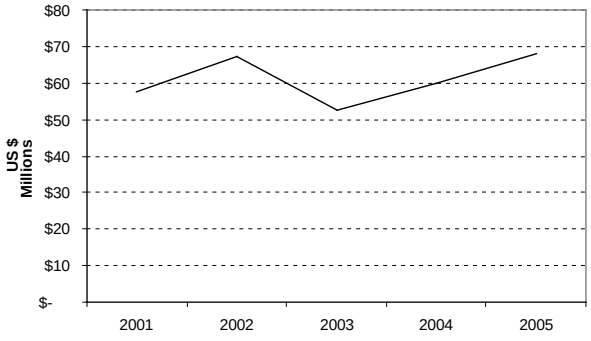
In order to maintain cold chains, air shipments of fresh seafood need to be delivered close to time of departure. Where the seafood is carried on passenger aircraft, there is the additional problem to ensure that the aircraft is not delayed in taking off. If the route involves a change in aircraft or significant time on the ground at an intermediate stop, this can also compromise the cold chain. In

order to minimize this problem, airlines now offer "tail to tail" service where cargo is moved directly from one plane to another. This also improves transit times and reduces handling costs.

Tanzania

Tanzania exports seafood to the E.U. This is predominantly West Nile Perch, which was introduced into Lake Victoria in the 1950s and 1960s.[40] About 2/3 of the West Nile perch are shipped fresh by air. Tanzania exports about 22,000 tons of fresh and frozen fillets worth $77 million. About 80 percent is sold to Europe and the rest to the Asian market.[41] The volume shipped has fluctuated (Figure 5-9) due to problems of supply, which requires the government to set quotas. There have also been problems with cholera outbreaks. In spite of these setbacks, the industry has flourished, and seven large-scale fish factories have been established. The two main competitors are Uganda and Kenya, which are also located on the lake. Tanzania has about 60 percent market share for this trade.

Figure 5-9. Tanzania seafood export to EU



Source: ITC

The fish are caught by individual fisherman as well as commercial fishing operations. Air shipments of 3–5 tons shipments are transported either to Mwanza or Nairobi. The cargo is driven from the factories and loaded at night for next morning delivery. For Mwanza, chartered aircraft are used. These are costly because the short runway restricts operations to older, smaller aircraft. Shipments through Kenyatta International Airport incur a higher land transport cost but the airfreight rates are lower. However, there is competition for the space on passenger aircraft especially during the peak seasons for shipments of flowers and vegetables. There are scheduled airfreight services but they are destined to Brussels, Liege, and Ostend and require transshipment for the final destinations in Spain, Italy and Germany. There are relatively few shipments large enough to justify chartering a larger airfreighter. The overall cost of transport to the market is estimated to be about $1 per kilogram.[42]

Ecuador

The Ecuadorian seafood trade is well established. It is a major exporter to North America shipping around 90,000 tons per year. Its location at the northwestern tip of South America near the intersection of the cold Humboldt with the warmer El Nino currents provides large amounts of Skipjack, Albacore, and Yellow Fin Tuna. In the late 1980s Ecuador modernized it fleets and nets.[43] In addition to ocean fish, there are shrimp farms in the warm waters of the Bay of Guayaquil. The latter have made Ecuador the world's biggest shrimp exporter, after overtaking Mexico in 1986,[44] and fresh

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[40] http://www.globefish.org/index.php?id=2405&easysitestatid=87650286. This site has an extensive analysis of East African exports of Wes Nile Perch to Europe, and is used widely in this summary.

[41] General Overview 2004/2005 at http://www.mwanza.de/mwanza/Mwanza%20CITY%20PROFILE%202004%20en.html

[42] Globefish.org http://www.globefish.org/index.php?id=2405&easysitestatid=87650286

[43] http://www.mongabay.com/reference/country_studies/ecuador/ECONOMY.html

[44] Ibid.

water fish farms for Tilapia. Other major importers of shrimp are Italy, France, Spain, Belgium and Holland.

About ¾ of the volume of seafood exports are shrimp, most of which are shipped frozen (Table 5-2). Shrimp farming was stimulated by growth in world market for high-value shrimp products in the 1980s. However, in 2000, the volume of exports declined and has only recently recovered (Figure 5-10) in part due to a reduction in price. Most of the shrimp is transported by sea but airfreight is used for the higher value forms.

Thailand is the main supplier of shrimp to the U.S. market with a 1/3 market share (Table 5-3). Ecuador is second exporter with a market share of about 12 percent. Other competitors include Indonesia, Vietnam and China. The market shares fluctuate due to changes in regional demand as well as supply. Although in second place in terms of volume, Ecuador is only in fourth position in terms of value. The shrimp is exported as head-on shrimp, in-shrimp tails raw as well as frozen shell-on, peeled and glazed. Peeled frozen shrimp accounts for about 1/5 of the volume of shrimp exports but ¼ of the value. The frozen shrimp are transported in waxed cardboard cartons consolidated into 50-pound boxes loaded into refrigerated containers. Airfreight is used upon request and is increasingly important for the higher value products including fully cooked, ready to eat shrimp.

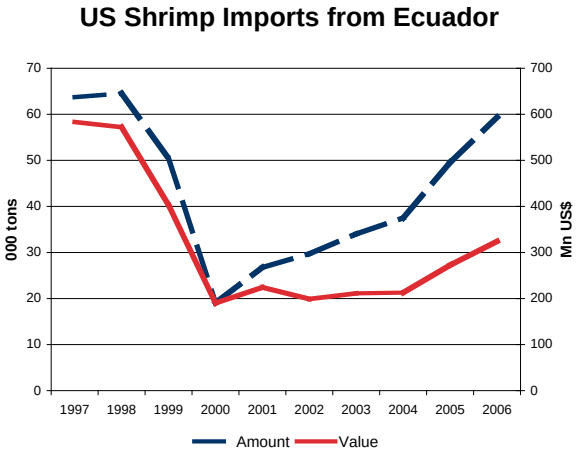
The principal fresh fish export is Tilapia. Production is increasing and is replacing some

Table 5-2. Exports of seafood from Ecuador to the United States, 2006

Product Type	Tons	US$ million	Avg Value $/kg
Shrimp (mostly frozen)	59,363	324.24	$5.46
Tuna (processed or in oil)	24,788	112.82	$4.55
Tilapia (mostly fresh)	11,119	70.83	$6.37
Marine Fish (mostly fresh)	6,727	31.24	$4.64
Dolphin (frozen)	2,802	15.60	$5.57
Sardines (mostly canned)	2,747	3.45	$1.26
Swordfish (mostly fresh)	481	3.41	$7.09
Crabmeat products	154	2.12	$13.75
Lobster (frozen)	93	1.33	$14.33
Snappers (mostly fresh)	179	1.02	$5.72
Fish stick products	120	.76	$6.32
Freshwater fish	213	.54	$2.53
All Others	3,036	4.04	
Total	**111,822**	**571.41**	

Source: Economic Research Service, US Dept of Agriculture, NOAA

Figure 5-10. U.S. shrimp imports from Ecuador



Source: NOAA data, MNFS Globefish

of the shrimp production. Ecuador produces around 2 percent of the world's tilapia, about 30,000 tons. About 95 percent of this is sold to the U.S. market and the rest to Colombia and other smaller markets. The exports account for about 12 percent of total seafood exports but faces stiff competition from China, which has about a 70 percent market share.

Table 5-3. United States shrimp imports by source

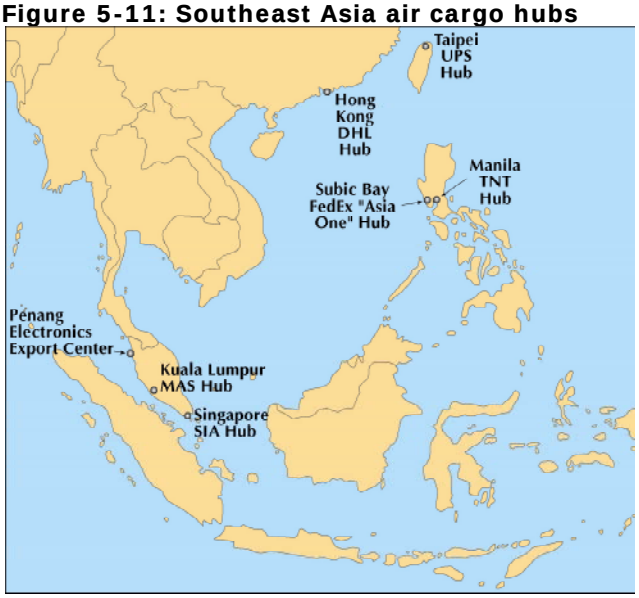
	January-Sept 2006		January-Sept 2007	
	tons	US$	tons	US$
Thailand	130,444	840	132,347	855
Ecuador	45,491	251	46,532	239
Indonesia	45,938	335	44,281	338
China	45,343	214	34,372	164
Vietnam	25,373	298	27,665	335
Mexico	10,600	107	17,014	147
India	20,624	187	15,623	146
Bangladesh	14,188	133	12,268	126
Other	63,385	391	61,857	339
Total	401,386	2,756	391,959	2709

Source: NMFS Globefish

Electronics Exports

Much of the modern electronics manufacturing industry is built around supply chains that use airfreight to move intermediate goods between the points of manufacture, assembly, and customization, and to distribute final goods and provide after-sales service. This is especially true for the just-in-time logistics that typify the production of semiconductors, computer equipment, measuring devices and high value consumer electronics.

Figure 5-11: Southeast Asia air cargo hubs



Source: Air Cargo: Growth and Issues, Thomas R. Leinbach, Department of Geography, University of Kentucky

The ASEAN region has developed a regional electronics industry. Singapore was a major production center for the semiconductor industry up until the 1980s when it shifted out of lower value-added assembly operations. It remains an important center for wafer fabrication but otherwise focuses on sales, distribution, and after-sales service taking advantage of its role as an airfreight hub.[45]

[45] The complexity of air cargo services in the electronics industry has been academically researched. Of note is an article written for the Journal of Economic Geography in 2002 by Thomas R. Leinbach of the University of Kentucky and John T. Brown, Jr. of University of Wisconsin at Oshkosh, titled "Air cargo services and the electronics industry in Southeast Asia." The paper will be cited extensively in this section.

Malaysia's electronics industry is dominated by semiconductor manufacturing, followed by some component manufacturing for computer parts and peripherals. Many of the semi-conductor companies originally went to Malaysia in the 1970s to take advantage of a low-cost labor force. They remained and as labor costs rose moved into both large wafer fabrication and cutting and processing of chips.

Table 5-4. Malaysian exports by destination

Country	000 tons (2005)	Share of Total
World	48,159	100.0%
USA	11,352	23.6%
Singapore	9,207	19.1%
Hong Kong	5,919	12.3%
Japan	3,591	7.5%
China	3,101	6.4%
Netherlands	1,539	3.2%
Taiwan	1,384	2.9%
Others	12,066	22.1%

Source: Department of Statistics, Malaysia, External Trade Division

The industrialization of Penang began in the 1960s. After Singapore, it was the obvious site for operations of American technology firms. The Penang Development Corporation, formed in November 1969, established a Free Zone in Bayan Lepas, which attracted Advanced Micro Devices, Agilent Technologies, Clarion, Fairchild Semiconductor, Hitachi Semiconductor, Intel, Osram Opto Semiconductors and Robert Bosch. In the 1980s, small and medium-sized industries were established to support these companies. In the 1990s there was a surge in research and development enterprises. The choice of Bayan Lepas for the free zone development was dictated by three key factors:

- proximity to the air cargo terminal to reduce trucking time/distances from the factory (for security reasons as the cargo was mostly classified as sensitive),
- integrated development with the free zone to accommodate the housing and commercial development, and
- proximity to the proposed Penang bridge which would provide ready access to the container port on the mainland (Butterworth).

With the expansion of the free zone, there was a parallel growth in the air freighter services and warehousing. Bayan Lepas airport became an international freight hub. The air cargo facility was expanded into a modern air cargo complex managed by the national airline (MAS). After 20 years, the demand grew to justify a second air cargo terminal operated by a private operator. A significant portion of the cargo is carried as belly cargo but there are scheduled freight services with FedEx providing direct connections to U.S. West Coast and the Asia Pacific region. In addition, MASkargo offers direct freight flights from Penang to key markets such as Europe, Japan and China. Initially MAS operated the ground handling services and air cargo facilities but this was transferred to the Malaysian Airport Company.

The growth in electronics was, in many ways, the beginning of the rapid growth in Malaysia's exports of manufactured goods. These continue to be moved primarily by sea through the regional transshipment ports including Port Kelang. Higher value exports to Europe and North America, as well as the re-export trade with East Asia tend to be moved through air transport (Table 5-4).

Sea-air services

The integration of air and sea transport for cargo movements was developed as a means to balance transit time and cost for shipments from Asia to Europe and North America. It began in the 1960s when Air Canada sought to fill spare capacity on its West Coast flights. It transported cargo arriving by sea in Vancouver from Yokohama and continuing on by air to Montreal and Toronto and from there to Europe. This attracted cargoes that required shorter transit times than offered by westbound all-water routes, such as photographic equipment. The success of this route led other west coast ports,

including Seattle and Los Angeles, to compete for cargo, especially from Korea. Traffic on this route eventually reached about 50,000 tons but began to decline in the mid 1980s when new routes were developed through Dubai.

The westbound sea-air service through Dubai utilizes Singapore as the shipping hub for goods shipped from East and South Asia. Containerized cargo is transported by sea to Dubai in 11–12 days. The containers are then removed from the vessel, the cargo stripped from the boxes, transported to the airport and loaded onto palettes for shipment by air to Europe. This transfer can be done in as little as 4 hours from the time the vessel arrives until the plane took off. The result is that cargo from Singapore can be at its final European destination within 14 days, effectively providing a two week delivery time for goods stored in Singapore and a 1½–2 month order cycle for reorders of goods from the manufacturer. At the same time, the cost is about ½ that of all-air shipments. This service attracts garments, electronics and other consumer goods that do not have the high-value, short shelf life of air freighted cargo. This traffic had already reached at 50,000 TEU (about 0.4 million tons) by the early 1990s.

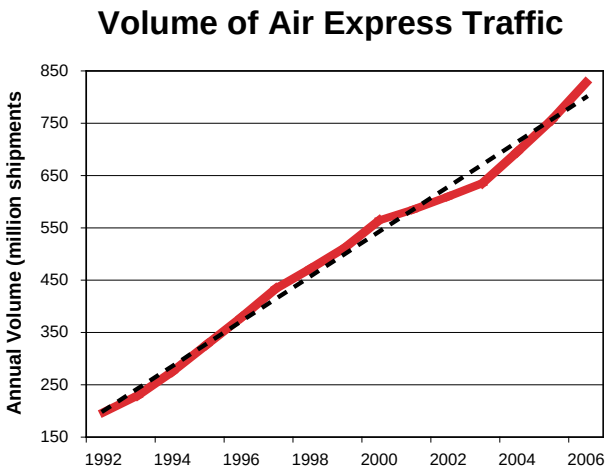
The frequency of air and ocean services and simplified administrative procedures have also allowed Dubai to attract sea-air traffic from the Far East (mainland China and Taiwan) and the Indian subcontinent (India and Sri Lanka) for shipments to Europe, Africa and the states of the former USSR. The success of Dubai led to competition from other airports in the United Arab Emirates, most notably from the airport in neighboring Sharjah. However, Dubai retains its dominant position because of the frequency of both air and sea services.

At the end of the 1990s, Korean Air launched a new sea-air service together with Hanjin Shipping for goods originating in China. This service utilizes container feeder services linking Tianjin, Shanghai, Qingdao, Dalian, and Weihai with the transshipment ports of Busan and Incheon. From there, the cargo is transported in bond to the nearby Incheon International Airport for both eastbound and westbound flights. However, the benefits of this service are gradually being eclipsed as the ports and airports in China develop faster direct services.

The Sea-Air services remain a niche business providing an attractive balance of time and cost for mid-value cargoes. At the same time, they are under constant competitive pressure from faster ocean services, such as the express services between China and Europe, and from improved management of supply chains. So far, the successful examples have been those serving major east-west trade routes, but there is potential for introducing this service on lower volume routes, especially between Africa and North America utilizing Dakar or a similar hub for the intermodal transfer. Similar opportunities exist for connections between Central Asia and Africa via the Gulf, as well as connections between South America and Europe. The greatest challenge is not to establish the airfreight services but to develop the efficient transfer operations, which, like air courier services, have simplified administrative and customs procedures.

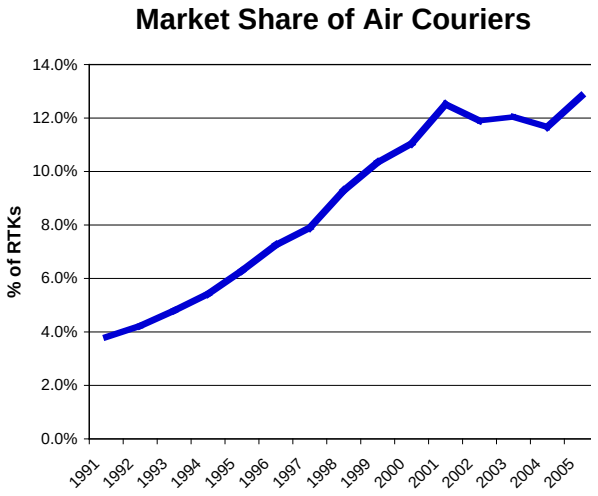
A variation on the Sea-Air service is Air-Sea combinations operating over shorter distances. These are often informal intermodal connections used to overcome specific shipping problems. In the case of South and Southeast Asia, this arrangement is used to compensate for delays in production that cause the normal shipping date to be missed. The air component is used to catch up with the scheduled vessel at a subsequent point on its route. Another option is the use of air to overcome unreliable land transport including cross-border movements used to reach gateway ports.

Figure 5-12. Volume of air express traffic



Source: International Air Freight and express Industry Performance Analysis, ACMG 2006

Figure 5-13. Market share of air couriers



Source: Boeing

Air express services

The activity of air courier services has grown rapidly over the last few decades. They began as express services carrying small packages and taking market share away from traditional postal and road-based courier services. However, as their volumes grew, they increased the size of shipments that they carried. The larger carriers such as DHL and FedEx acquired road haulage and airfreight companies allowing them to expand their presence in the traditional air cargo market. As the same time they expanded into multimodal transport and integrated logistics. These efforts have resulted in a quadrupling of volume over the last 15 years (Figure 5-12) and a doubling of market share (Figure 5-13).

The growth of these companies was supported by a rapid expansion in both the range of services offered and the geographical areas served. Their success led to the development of national courier services, which replicated their business model. Some, such as EMS in Southeast Asia, developed through a consortium of national postal services, but in larger markets such India and China multiple private services developed combining road and air transport.

In this regard, the histories of DHL and Blue Dart are informative. DHL was established in 1969 in San Francisco primarily as a forwarding company providing express services for documents sent from the U.S. West Coast to Far East and Pacific Rim countries. After ten years, it expanded its services to include packages and extended its service area to the Middle East and Africa. It continued to focus on logistics and utilized space on commercial airlines, especially scheduled passenger services. By 1985 it had established a major sorting hub in Brussels handling more than 165,000 shipments daily. In the 1990s, it expanded its presence in the Middle East by establishing a hub in Bahrain and obtaining contracts for shipment of essential goods. This traffic grew rapidly as a result of regional conflict and subsequent reconstruction. Currently, DHL serves this region through two hubs, Dubai and Bahrain, offering more than 30 flights per day, operating a large fleet of trucks and maintaining strategic parts centers in Bahrain, Dubai, Abu Dhabi, Kuwait, Riyadh, Jeddah and Dhahran. It operates its own aircraft but continues to rely on scheduled services for most of its traffic so that its fleet is much smaller than that of its competitors.

Like the other major integrators, DHL's rapid growth has been through a series of acquisitions. These include major freight and contract logistics companies such as:

- Air Express International – U.S. international forwarder (1999, $1.14 billion),
- Danzas – international freight forwarder (1999),
- ASG – Swedish Logistics (1999),
- Nedlloyd Logistics – European express services (2000),
- Airborne express – U.S. trucking operations (2003, €983 million),
- Exel – international logistics (2005, €5.5 billion).

DHL itself was acquired by Deutsche Post in 2002. The brand name has been maintained with the other services being integrated into DHL Global.

In 2005, DHL acquired an 81 percent stake in the Indian courier service Blue Dart though its subsidiary DHL Express (Singapore) Pte for Rs.5.56 billion ($128 million). Blue Dart was established in 1983 to provide both domestic and international shipments using available airline services. In 1994, the company became Blue Dart Aviation through an IPO, which allowed it to acquire its own aircraft. By 2001, the company's turnover exceeded Rs1 billion. Though acquired by DHL, it continues to operate as an independent brand.[46] In 2006, it expanded its air cargo capacity by 50 percent through the acquisition of two Boeing 757 airfreighters (Figure 5-14) to complement its fleet of four Boeing 737's. An additional 757 was added in 2007. The fleet continues to operate with load factors in excess of 90 percent and transports up to 250 tons per day on a total of 60 routes. It operates out of six hubs: Delhi, Mumbai, Chennai, Kolkata, Bangalore and Ahmedabad. In its larger hubs, the company has 15-30 thousand square meters of warehousing for sorting and storage

The company operates a few international flights but relies primarily on connections through DHL and other commercial airlines. It also outsources a small portion of its shipments, most notably those to Sri Lanka, Bangladesh and the Maldives.

The company's market share of the domestic air courier business is about 42 percent but only about 6 percent for ground express services where it faces formable competition.[47] Its current plans are to dramatically improve its ground transport capacity through a $250 million investment to expand its network, upgrade its vehicle fleet, acquire additional warehousing and ground handling equipment for the airports and add to its 15,000 service centers

At present, the major of shipments are documents and samples, but with the improved capacity and network, the company will have opportunities for handling larger shipments of air cargo. For this purpose it will target the organized retail sector as well as the growing number of SEZs and IT parks.
The company has substantial potential for growth as the volume of airfreight in India is in excess of ½ million tons of freight handled at domestic airports and almost 1 million tons at its international airports. The traffic at the major airports has shown steady growth over the last decade (Figure 5-15) and is likely to accelerate with the growth in the economy and reform in the transport sector.

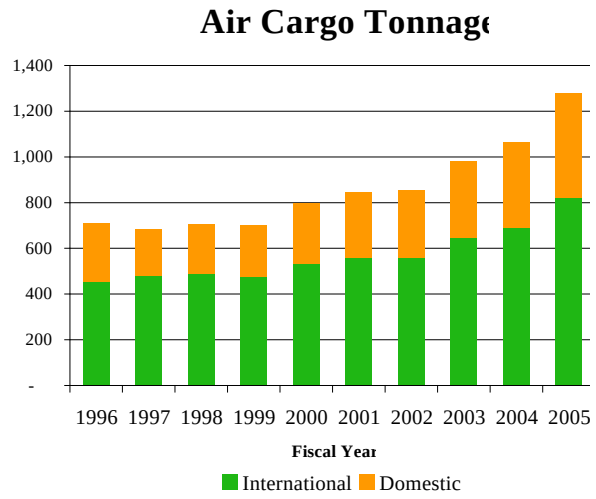
[46] There are similar tie-ups between UPS and Jet Airways and FedEx and Prakash Airfreight.

[47] For ground express services, Blue Dart faces formidable competition from two local companies Gati and Safexpress

Figure 5-14. Blue Dart 757 airfreighter

Source: Blue Dart website

Figure 5-15. Air cargo tonnage



Source:

Viracopos Airport (VCL)

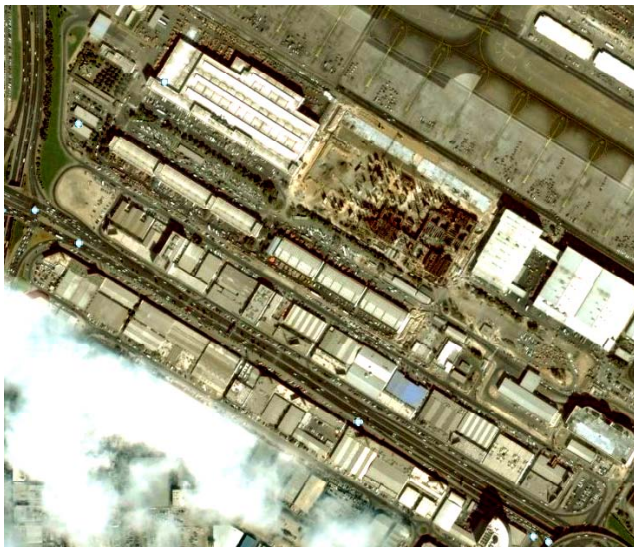
The Viracopos Airport in Brazil is a single runway facility located about 90 kilometers northwest of Sao Paulo in the Campinas area. The second-largest airport in terms of air cargo, it handled about 172,000 tons in 2004, a third of Brazil's airfreight imports and nearly 40 percent of its exports.[48] The airport is open all but 5–8 days a year. Originally an international passenger airport, it was converted to a cargo airport in 1985, when the passenger flights were rerouted to Guarulhos Airport which is nearer to Sao Paulo, Brazil's busiest airport.

The conversion to a cargo airport was possible because of the demand from the surrounding electronics industry. As much as 90 percent of inputs for these companies was brought in by air. There was also a concentration of instrumentation manufacturers, including aircraft instruments. The airport participated in a successful pilot program for streamlining customs clearances in the late 1990s. The improved efficiency of customs was important for the local industries and also was a factor in attracting UPS to serve the airport. Infraero, the government-owned airport holding company, has made extensive investments in the airport ($87 million from 2002–2007) in order to develop a regional cargo hub not just for Brazil but also for all of Latin America. A second, longer runway is planned for the airport.

The rise of the electronics industry in Brazil, just as in Southeast Asia, is linked to the existence of the airport. Campinas is a center for both semiconductor and electronic data processing manufacturing. The industry, developed in the 1970s, relied heavily on imported materials and components. While final products were targeted primarily for domestic consumption, the infrastructure for the logistics supply chain limited imports and therefore production. In 1998, Customs introduced a special line that allowed accredited firms to declare goods prior to arrival and to reduce the number of inspections. In the same year, UPS introduced a dedicated five-day-a-week express delivery service to and from the Mercosur region via Viracopos Airport in partnership with Challenge Air Cargo. In 2003, FedEx

[48] In 2003, the airport handled 21 thousand tons of domestic cargo, 63 thousand tons of exports and 75 thousand tons of imports

Figure 5-16. Dubai Cargo Village



Source: Google Earth

Figure 5-17. Mega Cargo Terminal

Source: Dubai Airport website

expanded its bonded sorting facilities in the airport to 2,000 sq. m. In 2007 Infraero invested about $67 million to build a new express cargo terminal.

Dubai Cargo Handling Facilities

Dubai International Airport is one of the fastest growing passenger and cargo airports in the world. Since the establishment of its cargo village (Figure 5-16) in 1991, it has experienced double-digit growth in import, export and transshipment cargo. In 2007, it handled a total of 1.66 million tons. The cargo village occupies some 30 ha and has seven terminals as well as an office building for the airlines and 17 aircraft parking stands. Among its facilities are the Main Cargo Terminal with ground area of about 25,000 sq. m. and 56 truck docks and an annual capacity in excess of 400,000 tons, and the Emirates Sky terminal with 28 truck docks and an annual capacity of 350,000 tons.

The most recent addition is the multi-storey Cargo Mega Terminal (Figure 5-17) with capacity of 1.2 million tons and footprint of about 36,000 sq. m. The building has three levels: the ground floor has a clearance of 12 meters for processing export and import cargo, the second floor has a clearance of 8 meters to be used for transshipment cargo, and the third level has a 4.5 meters for a ULD repair workshop and storage for empty ULDs (unit load device), wooden pallets, timber spreaders. There are plans to expand the Mega terminal by adding two additional buildings.

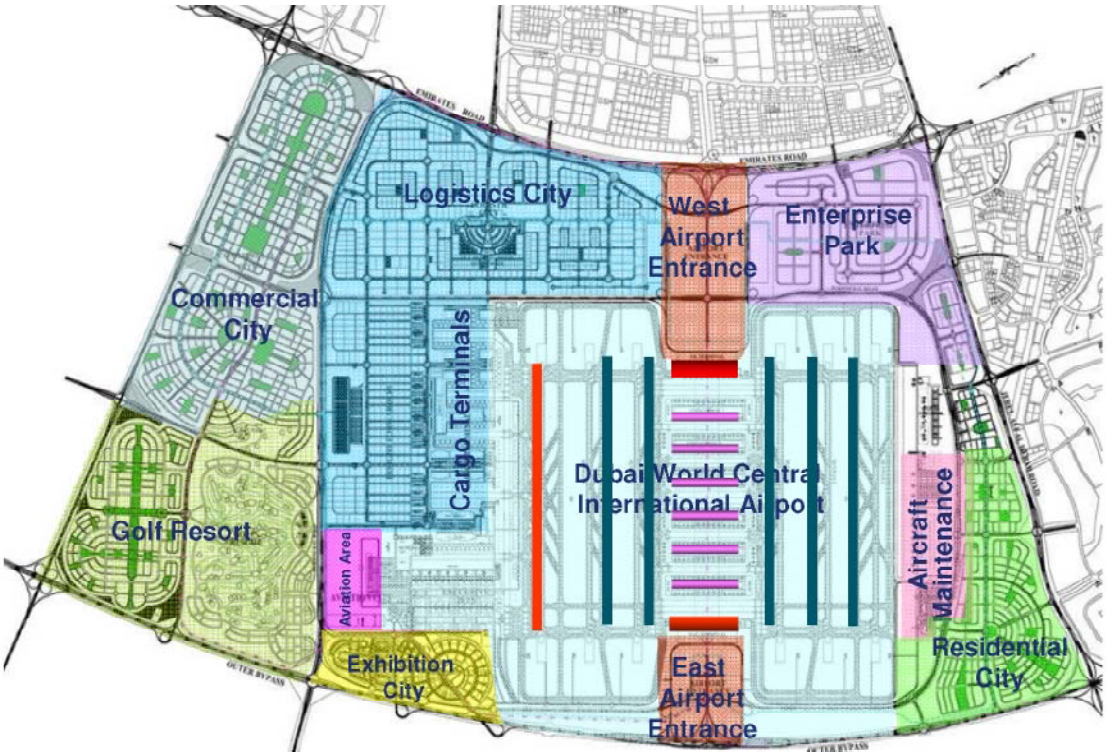
Another addition to Dubai's cargo handling facilities is the recently constructed flower center with a 10,000 sq. m. footprint and 3 levels modeled on a similar facility in Amsterdam. The target market was producers from East and West Africa but efforts are now being made to attract shipments from South and Central Asia. It was built to handle both imports and transshipment. The warehouse also provides facilities for preparation of floral arrangements. In order to make better use of its 150,000 ton annual capacity, the facility can also be used for handling other perishables.

Among the activities that are supported are consolidation/repackaging for transshipment; pre-assembly of product lines sourced from around the world; pack house for fruit and vegetable and value-added services, for example bouquet making. The DFC has specialized facilities including laboratories, quality control operations, customs inspection, break and build areas and specialized cool-storage chambers. There are refrigerated dollies to transfer palettes between the DFC and

aircraft, automated X-ray scanners for perishable cargoes and temperature- controlled air locks to the storage area. Customs, phytosanitary inspections and clearance services are performed on the main floor in the central handling area for import, export and transit.

By 2010, the Dubai International Airport's turnover is expected to increase to more than three million tons. Capacity will be increased to five million tons when the Cargo Mega Terminal is completed as part of the current development program. These facilities will be supplemented by the new cargo facilities at Al Maktoum International Airport adjoining the Jebel Ali Free Zone (Figure 5-18). While the first phase is only planned to handle 200,000 tons, the fully developed facility will have an annual capacity of 12 million tons.

Figure 5-18. Jebel Ali Airport layout



ANNEX A: ADDITIONAL TABLES

Table A-1. Top ten air cargo carriers (million FTK)

		2006	2005	
1	FedEx	15,145	14,408	5.1%
2	UPS	9,341	9,075	2.9%
3	Korean Air	8,764	8,072	8.6%
4	Lufthansa	8,091	7,680	5.4%
5	Singapore	7,991	7,603	5.1%
6	Cathay Pacific	6,914	6,458	7.1%
7	China Airlines	6,099	6,037	1.0%
8	Air France-KLM	5,868	5,532	6.1%
9	Cargolux	5,237	5,149	1.7%
10	Eva Air	5,160	5,285	-2.4%

Source: Air Cargo World

Table A-2. Ranking of US cargo carriers

Rank	Carrier	2005
1	FedEx	10,028
2	Atlas/Polar	5.890
3	UPS	5,776
4	Northwest	2,257
5	American	2,216
6	United	2,020
7	Kalitta	1,562
8	Delta	1,341
9	Continental	941
10	Evergreen	829
11	Gemini	826
12	World	680
13	ABX	618
14	Tradewinds	489
15	US Airways	344
16	Omni	344

Source : Air Cargo Worldwide

Table A-3. Ranking of airfreight carriers, 2005

	Cat	Company	Country	Millions FTKs	% Change 2005 -2004
1	I	Federal Express	United States	14,408	-1.2
2	I	United Parcel Service	United States	9,075	23.4
3	C	Korean Air	South Korea	*8,072*	-2.3
4	C	Lufthansa	Germany	7,680	-4.5
5	C	Singapore	Singapore	*7,603*	6.4
6	C	Cathay Pacific	Hong Kong	*6,458*	9.9
7	C	China Airlines	Taiwan	*6,037*	7.0
8	F	Atlas Air	United States	6,002	8.4
9	C	Air France	France	5,532	2.7
10	C	EVA Air	Taiwan	*5,285*	-3.5
11	F	Cargolux	Luxembourg	5,149	10.3
12	C	JAL	Japan	*4,817*	-2.2
13	C	British	United Kingdom	4,767	-0.2
14	C	KLM	Netherlands	4,646	2.4
15	C	Emirates	UAE	4,192	14.5
16	C	Northwest	United States	3,210	4.6
17	C	Martinair	Netherlands	3,026	-3.5
18	C	American	United States	2,905	1.8
19	C	Air China	China	*2,717*	6.5
20	C	United	United States	2,649	3.0
21	F	Polar Air	United States	2,599	-23.8
22	C	Malaysia	Malaysia	*2,576*	-0.7
23	C	Asiana	South Korea	*2,433*	-8.8
24	F	Nippon Cargo	Japan	*2,417*	0.7
25	C	Qantas	Australia	*2,371*	1.4
26	C	China Cargo	China	*2,250*	19.9
27	F	Kalitta Air	United States	2,094	38.5
28	C	Thai Airways	Thailand	*2,002*	6.8
29	C	Delta	United States	1,760	-0.6
30	C	Lan Chile	Chile	1,753	3.9
31	C	China Southern	China	*1,672*	4.6
32	F	ABX Air	United States	1,534	66.9
33	C	All Nippon	Japan	*1,418*	2.9
34	C	Dragonair	Hong Kong	*1,404*	30.2
35	C	Alitalia	Italy	*1,365*	-2.0
36	C	Air Canada	Canada	*1,267*	-7.3
37	F	China Cargo	China	*1,257*	8.0
38	C	Continental	United States	*1,228*	15.0
39	C	Varig	Brazil	*1,227*	-0.3

40	F	Evergreen International	United States	*1,210*	12.5
41	L	Gemini Air Cargo	United States	*1,206*	1.8
42	C	Virgin Atlantic	United Kingdom	*1,157*	7.2
43	C	Swiss International	Switzerland	*1,110*	1.8
44	C	Saudi Arabian Airlines	Saudi Arabia	*1,021*	6.7
45	C	World Airways	United States	*992*	-54.1
46	C	Iberia	Spain	*973*	-1.0
47	C	South African Airways	South Africa	*911*	-0.7
48	C	El Al	Israel	*878*	-10.6
49	C	Qatar Airways	Qatar	*870*	85.5
50	C	Aeroflot	Russia	*793*	8.5

Table A-4. Fleet configuration of major airfreight companies

Operator	Total Fleet	727/ 737	757/ 767	777	747	DC-8 /DC-9	MD11/ DC10	A300	A310	ATR
ABX	93		33			60				
Astair	38	29				9				
Atlas/Polar	38				38					
Blue Dart	7 [7]	5	2							
Cargolux	15 [11]				15					
DHL Air	22 [22]		22 (12)							
Evergreen	18 [6]				13	5				
FedEx	375 [92]	97	4	(15)			143	60 (3)	68	3
Lufthansa Cargo	21 [16]				2		19			
Martanair	23 [22]		6		5		7	5		
UPS	282	31	107		11	46	34	53		

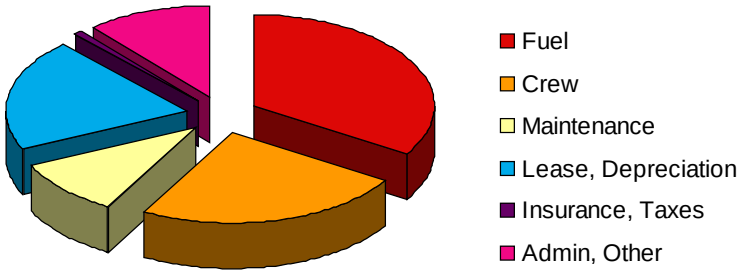
Source: Air Transport World, July 2007, ATA Annual Report 2007; numbers in parentheses are on order, in brackets are leased in.

Table A-5. Capacity of Air Freighters

	Max takeoff weight		Fuel Capacity		OEW	Typical payload	Max. cargo volume
	tons	less fuel	000 liters	tons	tons	tons	m3
737-200	52.4	43.1	18.1	14.5	27.1	3.2	24.8
737-200F	52.4	43.1	18.1	14.5	30.3	12.8	102.5
A300-600	171.7	130.0	68.2	54.5	90.9	34.9	
A300-600F	170.5	130.0	68.2	54.5	81.9	48.1	113.4
747-400	379.8	246.1	216.8	174.1	178.8	67.4	181.0
747-400 Combi	397.0	240.9	216.8	174.1	169.0	72.2	299.0
747-400F	397.0	288.0	216.8	174.1	165.3	122.7	702.0
A380	560.0	361.0	310.0	248.0	276.8	66.0	
A380 F	592.0	427.0	310.0	248.0	252.2	150.0	

Source: Manufacturers' Websites

Figure A-1. 747-400 operating cost



Source: Air Cargo Economics, MIT-ICAT 2004
ocw.mit.edu/.../16-886Spring2004/8AB810F2-F510-4305-B863-F638262CA692/0/06cargo_econmics.pdf

Table A-6. Typical capacity for air freighters

Aircraft	Volume	Max weight	Unit Load Device
	cu.m.	m.ton	
737-300	21	2.25	
737-400	24	2.9	
737-200	70	19.5	6 LD7, 4 LD3,
767-300	63	16.5	4 LD8, 3 LD7
777-200	61	21	4 LD7, 4 LD3
747F	601	95	29 M1, 9 LD7, 2 LD3
MD-11 CF	543	82	26 M1, 6 LD7, 7LD3
A330-300	86	13.5	6 LD7, 4 LD3
A330-300 (H)	86	21	6 LD7, 4 LD3
Ilyushin IL-76	220	45.8	
Antonov An-12	97	20	

Source: World Class Shipping, http://www.worldclassshipping.com/aircraft.html

Table A-7. Airfreight performance statistics, 2006

	% of Direct Operating Costs		
	Fuel	Maintenance	000 Liters/ Air Hour
DC-9-40	35.2%	23.1%	4.05
B757-200	30.6%	26.0%	4.70
B727-100	15.3%	51.5%	5.19
B727-200	23.9%	24.3%	5.85
B767-200	38.2%	27.0%	5.90
B767-300	46.6%	16.5%	6.41
A310-200c/F	27.0%	25.6%	6.71
A300-600	32.1%	18.3%	7.12
DC-8-73	23.5%	38.3%	7.24
DC-10-30	40.3%	28.5%	9.72
MD-11	37.8%	18.9%	9.83
B747-400	39.9%	13.6%	11.94
B747-100	56.2%	18.7%	14.28

Source: DOT Form 41

Table A-8. Aircraft average operating costs per block hour, 2000

	Fuel Consumption		Direct Operating Costs (US$)			
Aircraft	liters	tons	Fuel	Other	Total	Fuel %
A300-600	7,100	5.11	1,588	2,002	3,590	44%
A319	3,121	2.25	698	1,458	2,156	32%
A320	3,367	2.42	753	1,520	2,273	33%
A321	3,519	2.53	787	1,736	2,523	31%
A330-200	6,698	4.82	1,498	2,203	3,701	40%
A330-300	7,109	5.12	1,590	2,213	3,803	42%
A340-300	8,263	5.95	1,848	2,225	4,073	45%
A340-600	9,819	7.07	2,196	2,654	4,850	45%
ATR-42	760	0.55	140	1,006	1,146	12%
ATR-72	814	0.59	150	1,353	1,503	10%
B-727-200	4,045	2.91	745	1,874	2,619	28%
B-737-200	3,024	2.18	557	1,430	1,987	28%
B-737-200C	4,316	3.11	795	1,981	2,776	29%
B-737-300/700	2,622	1.89	483	1,510	1,993	24%
B-737-400	3,062	2.20	564	1,686	2,250	25%
B-737-800	2,145	1.54	395	1,188	1,583	25%
B-737-500	3,057	2.20	563	1,513	2,076	27%
B747-100	15,235	10.97	2,806	4,950	7,756	36%
B-747-200	15,289	11.01	2,816	5,608	8,424	33%
B-747-400	14,225	10.24	2,620	4,141	6,761	39%
B-757-200	3,420	2.46	630	2,055	2,685	23%
B-767-200	4,626	3.33	852	2,365	3,217	26%
B-767-300	4,930	3.55	908	2,490	3,398	27%
B-777-200	7,330	5.28	1,350	2,799	4,149	33%

Source: ICAO - Fourth Meeting of the ALLPIRG/Advisory Group, Appendix ALLPIRG/4-WP/28

ANNEX B. CONVENTION ON INTERNATIONAL CIVIL AVIATION

This convention was signed in Chicago on December 7, 1944 and is currently in its 9th edition (2006). It continues to serve as the basic document governing the relationship between states on the exchange of commercial air traffic rights, although it was adopted at a time when almost all airlines were national flag carriers and the carriage of cargo by air was just beginning. The basic principle of the Chicago Convention was that treaties allowing airlines to fly between countries would be bilateral in nature, negotiated between governments, and that airlines would generally only be allowed to fly either from or to their home country.

Among the provisions are:

"No state aircraft of a contracting State shall fly over the territory of another State or land thereon without authorization special agreement or otherwise, and in accordance with the terms thereof." (Article 3c)

"Each contracting State shall have the right to refuse permission to the aircraft of other contracting States to take on in its territory passengers, mail and cargo carried for remuneration or hire and destined for another point within its territory. Each contracting State undertakes not to enter into any arrangements which specifically grant any such privilege on an exclusive basis to any other State or an airline of any other State, and not to obtain any such exclusive privilege from any other State..." (Article 7)

"...aircraft, if engaged in the carriage of passengers, cargo, or mail for remuneration or hire on other than scheduled international air services, shall also, subject to the provisions of Article 7, have the privilege of taking on or discharging passengers, cargo, or mail, subject to the right of any State where such embarkation or discharge takes place to impose such regulations, conditions or limitations as it may consider desirable." (Article 5)

From this Convention, seven "Freedoms" to be incorporated in bilateral agreements were evolved as follows:

- First or Transit Freedom: The right to fly across another country without landing.
- Second Freedom: The right to land in another country for purposes other than carrying passengers, for example re-fueling or maintenance.
- Third Freedom: The right to land in another country from the home country for purpose of commercial services.
- Fourth Freedom: The right to fly from another country to the home country for purpose of commercial services. (Together the Third and Fourth Freedoms grant the rights to load and unload passengers, mail and cargo in another country.)
- Fifth Freedom: The right to carry passengers to one country, and then fly on to another country with the right to carry passengers and cargo from second country to the third country and from the third country to the second country.
- Sixth Freedom: The combination of third and fourth freedom traffic rights, i.e. the right of a national carrier of one country to carry traffic from a point of origin in another country to a destination in a third country via the country of the airline (this is not a right usually granted under bilateral air services agreements).
- Seventh Freedom: the right to operate stand-alone services between two other countries.

- Eighth Freedom ("cabotage") - the right to carry traffic from one point in the territory of a country to another point in the same country.

The Eight Freedoms of the Air

- First: An airline may overfly one country to reach another.
- Second: An airline may land in another country for a technical stopover (fuel, maintenance, crew change) but not to pick up or drop off traffic.
- Third: An airline, registered in country X, may drop off traffic from country X into country Y.
- Fourth: An airline, registered in country X, may carry traffic back to country X from country Y.
- Fifth: An airline, registered in country X, may collect traffic in country Y and fly on to country Z, so long as the flight either originates or terminates in country X.
- Sixth: An airline, registered in country X, may carry traffic to a gateway – a point in country X – and then abroad. The traffic has neither its origin nor ultimate destination in country X.
- Seventh: An airline, registered in country X, may operate entirely outside of country X in carrying traffic between two other countries.
- Eighth: An airline, registered in country X, may carry traffic between any two points in the same foreign country – known as *cabotage*.

ANNEX C. CARGO AIRCRAFT

There is a wide range of aircraft used as air freighters. Broadly they can be grouped by capacity into narrow-bodied aircraft with capacity of less than 25 tons, medium wide-bodied aircraft with capacity of less than 80 tons and large wide-bodied aircraft with capacity of 80 tons or more (Table C-1). Although the large wide-bodies account for only about 1/6 of the total fleet, they provide about 26 percent of the total capacity. In contrast, the narrow-bodies account for 35 percent of the fleet but only 12 percent of the total capacity.

The capacity of air cargo aircraft is a function of the Maximum Takeoff Weight less the weight of the airframe and the fuel. The weight of the airframe is referred to as the Operational Empty Weight (OEW). This value, along with the implied maximum payload weight, is shown for selected air freighters in Table C-2. As shown in this table, there is a significant tradeoff between the amount of fuel carried and thus the operating range and the maximum weight of the cargo. The increase in payload, with a reduction from a full load of fuel to a 2/3 load, is 60–100 percent.

Airfreight carried in both air freighters and commercial aircraft moves in a variety of unit load devices (ULD). There are four major categories as follows

- built up or half pallets, rigid or flexible.
- wood containers and crates design for pallets.
- rigid aluminum containers designed for specific aircraft. and
- ISO intermodal containers

Table C-1. Airfreight maximum payload

Aircraft	Typical Payload Tons	Loadable Volume CBM3
Narrow-body		
ATR42	4.6	40
AN74	6.5	45
737-200F	15	105
AN12	18	90
727-200F	23.5	144
Medium Wide-body		
757F	39	187
A300B4F	43.5	280
IL76	45	180
AN22	50	650
767-300F	60	454
DC10-30	65	451
Large Wide-body		
MD11	80	642
747-100F	96	724
747-200F	110	725
747-300/400F	120	764
AN124	120	800
AN225	250	1100

Source:ALLPIRG/Advisory Group, 201

Typical ISO ULDs are shown in Figure C-1. The number of these units that can be stored in the typical air freighters is shown in Table C-3.

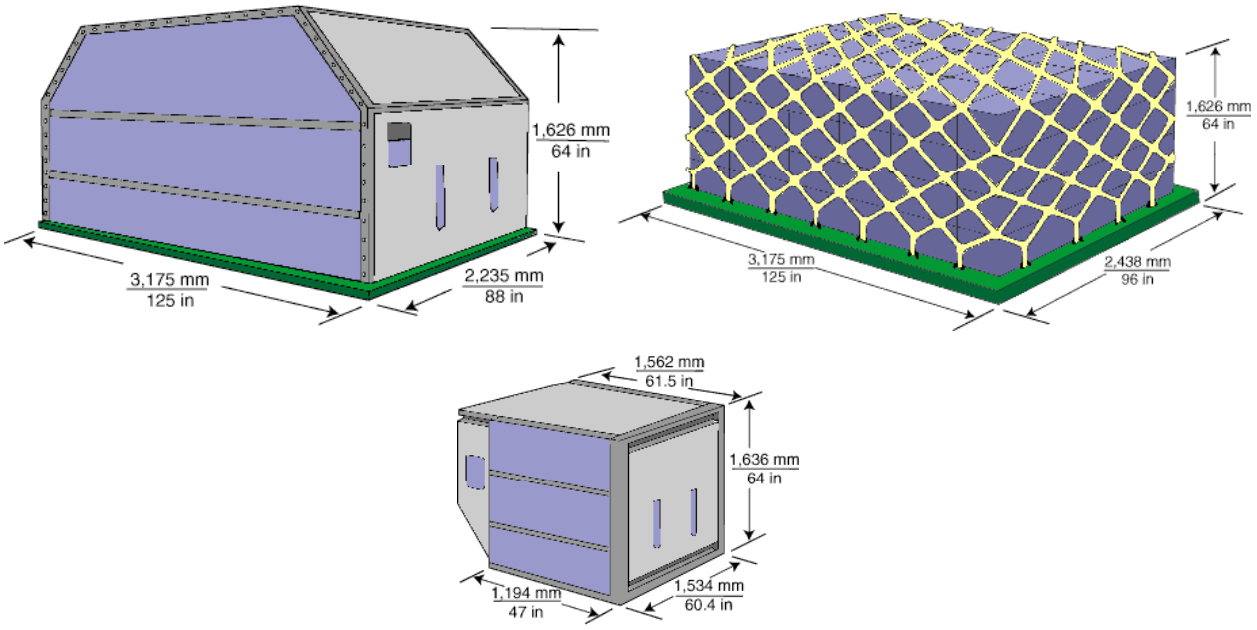
Table C-2. Capacity of air freighters

	Max takeoff weight	Fuel Capacity		OEW	Payload Max Range	Payload 2/3 Range	Max. cargo volume
	tons	000 liters	tons	tons	tons	tons	m3
737-200F	52.4	18.1	14	30.3	8	13	102.5
A300-600F	170.5	68.2	52.5	81.9	36	54	113.4
747-400 Combi	397.0	216.8	167	169.0	21*	78*	299.0
747-400F	397.0	216.8	167	165.3	65	121	702.0
A380 F	592.0	310.0	238	252.2	102	183	

** Assumes 40 tons for passengers and baggage*

Source: Manufacturers Websites

Figure C-1. LD-7 container and pallet and LD-2 container



Source: http://www.elitelogistics.com/uld.php

Table C-3. Typical Capacity for Air Freighters

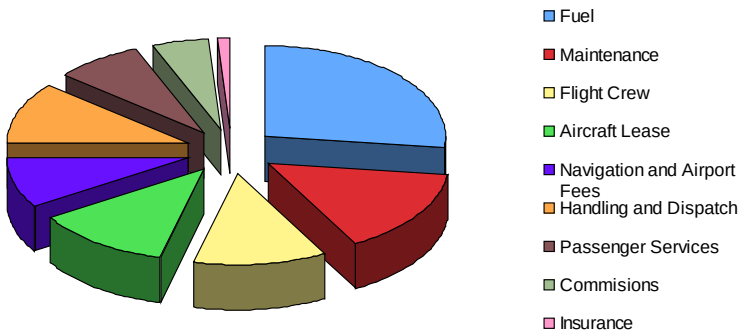
Aircraft	Volume	Unit Load Device
	cu.m.	
737-200	70	6 LD7, 4 LD3,
767-300	63	4 LD8, 3 LD7
777-200	61	4 LD7, 4 LD3
747F	601	29 M1, 9 LD7, 2 LD3
MD-11 CF	543	26 M1, 6 LD7, 7LD3
A330-300	86	6 LD7, 4 LD3
A330-300 (H)	86	6 LD7, 4 LD3

Source: World Class Shipping, http://www.worldclassshipping.com/aircraft.html

ANNEX D. OPERATING COSTS

Information on operating costs is available in different forms. The two principal sources are the information collected by U.S. DOT on Form 41 from each of the airlines operating in the U.S. and data collected from member airlines by IATA, ATA and ICAO (Table D-1, Figure D-1). The U.S. DOT data are compiled annually, whereas the latter are compiled for occasional reports. An analysis of the direct operating costs per block hour for a variety of aircraft was prepared in 2000 (Table D-2). However, these were passenger aircraft, which implies higher fuel consumption, and additional maintenance costs per block hour because of more frequent takeoffs. It also implies that the capital costs per block hour would be lower than for cargo aircraft because of higher level of utilization. In order to obtain a better approximation of cargo aircraft operation, U.S. DOT data was used

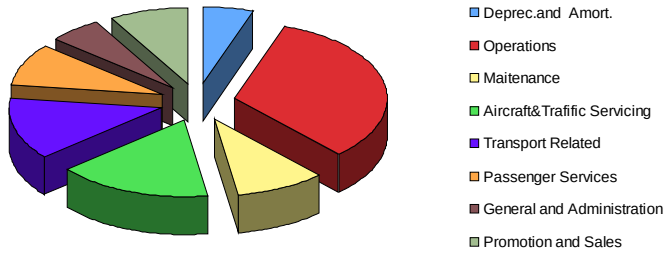
Figure D-1. Direct operating costs, 2001



Source: ICAO

Detailed cost data is reported by the U.S. airlines on Form 41. This includes data on the operating costs for individual aircraft. The data is aggregated by function, including direct operating costs, ground handling, passenger related services (in-flight, sales and reservations, airport processing), administrative and promotional costs as shown in Figure D-2 for 2004. Direct operating costs, including crew, fuel, maintenance and capital costs account for only about half of the total airline costs. Ground operations account for approximately 30 percent and general management and in-flight services accounting for the remainder.

Figure D-2. U.S. airline costs by function, 2004



Source: ATA Annual Report 2005

Information on individual aircraft from 2006 has data in terms of fuel, maintenance, capital and crew. Data is also provided on operating hours and availability in terms of days per year. The database has a number of problems. It is difficult to separate crew costs since they are included in the rentals for wet leases. The same applies for maintenance costs. By combining rentals with costs for depreciation and amortization, there is an overestimate of capital costs. In addition, the database contains numerous inaccuracies. Not only is a significant portion of the data missing, but many of the items are clearly incorrect, due either to the values reported or poor data entry. For example, annual operating hours range in value from 20 to 20,000. The only data that appears robust is the fuel consumption per block hour. On the other hand, the fuel costs have little relationship to the block hours. For this reason, the fuel costs were recalculated using the reported consumption multiplied by an average cost for fuel of $0.75 per liter. The maintenance costs vary depending on the age of the aircraft with the oldest, B-727, DC-9, DC-10, and B-100 having the highest cost relative to their replacement costs. For the aggregate data, it appears that the average maintenance costs for 4,000–5,000 hours is about 7–10 percent of the replacement cost for an aircraft about 10–20 years. Adding to this a crew cost of $1.6 million and a capital cost of 8 percent of replacement cost, the estimated operating cost per block hour would be $3,000, $6,000 and $11,000 peer block hour for narrow-bodied, medium wide bodies and large widebody aircraft respectively.

Table D-1. Estimated airfreighter operating costs, 2008 (US$)

	Average Operating Costs per Hour of Operations				Average Operating Hours
	Fuel	Crew, Rentals	Maintenance	Total Direct	
B727-200/231A	4,086	2,739	4,001	12,095	4,420
B737-200C	2,424	995	1,066	5,061	913
B757-200	3,525	2,192	2,113	9,181	5,602
B767-300/300ER	4,747	1,916	1,447	8,815	7,477
DC-9-40	5,045	3,048	2,598	11,484	1,702
A300-600/R/CF/RCF	5,252	5,153	2,013	12,111	5,604
A310-200C/F	5,108	4,166	3,505	14,848	4,079
DC-10-30CF	7,526	2,973	3,487	14,086	4,007
MD-11	7,343	4,261	2,067	15,139	6,607
B747-100	10,983	1,879	2,800	16,406	1,457
B747-200/300	10,076	2,501	1,945	15,295	2,424
B747-400	8,899	3,249	1,050	13,838	3,488
B747F	11,181	1,721	2,687	16,583	5,726

Source: US DOT Form 41 modified based on fuel cost $0.75 per liter and 5% inflation over 2006

Table D-2. Aircraft average operating costs per block hour, 2000

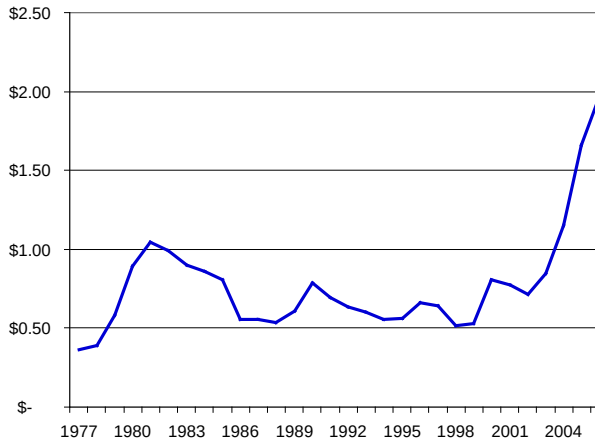
	Fuel Consumption		Direct Operating Costs (US$)				2006
Aircraft	liters	tons	Fuel	Other	Total	Fuel %	Total
A300-600	7,100	5.11	1,588	2,002	3,590	44%	
A319	3,121	2.25	698	1,458	2,156	32%	
A320	3,367	2.42	753	1,520	2,273	33%	
A321	3,519	2.53	787	1,736	2,523	31%	
A330-200	6,698	4.82	1,498	2,203	3,701	40%	
A330-300	7,109	5.12	1,590	2,213	3,803	42%	
A340-300	8,263	5.95	1,848	2,225	4,073	45%	
A340-600	9,819	7.07	2,196	2,654	4,850	45%	10.034
ATR-42	760	0.55	140	1,006	1,146	12%	
ATR-72	814	0.59	150	1,353	1,503	10%	
B-727-200	4,045	2.91	745	1,874	2,619	28%	
B-737-200	3,024	2.18	557	1,430	1,987	28%	
B-737-200C	4,316	3.11	795	1,981	2,776	29%	4,127
B-737-300/700	2,622	1.89	483	1,510	1,993	24%	
B-737-400	3,062	2.20	564	1,686	2,250	25%	
B-737-800	2,145	1.54	395	1,188	1,583	25%	
B-737-500	3,057	2.20	563	1,513	2,076	27%	
B747-100	15,235	10.97	2,806	4,950	7,756	36%	12,487
B-747-200	15,289	11.01	2,816	5,608	8,424	33%	11,688
B-747-400	14,225	10.24	2,620	4,141	6,761	39%	10,3636
B-757-200	3,420	2.46	630	2,055	2,685	23%	7,737
B-767-200	4,626	3.33	852	2,365	3,217	26%	
B-767-300	4,930	3.55	908	2,490	3,398	27%	7,039
B-777-200	7,330	5.28	1,350	2,799	4,149	33%	

Source: ICAO - Fourth Meeting of the ALLPIRG/Advisory Group, Appendix ALLPIRG/4-WP/28

ANNEX E. FUEL EFFICIENCY[49]

The consumption of fuel has increased in importance dramatically over the last decade primarily as a result of a dramatic increase in the cost of fuel as shown in Figure E-1. Up until 1998 there had been a steady decline in fuel price in current terms and a substantial decline in constant terms. This was complemented by a steady improvement in fuel efficiency of aircraft as a result of improvements in both the engines and the airframes (Figure E-2). Fuel consumption is proportional to the weight as well as the coefficients for drag and lift. The introduction of winglets and other design features to reduce drag have produced fuel savings. In addition, improvements in the engines have reduced the fuel consumption per unit of thrust and allowed engines to be configured for greater efficiency during take-off, climbing, and during cruising.

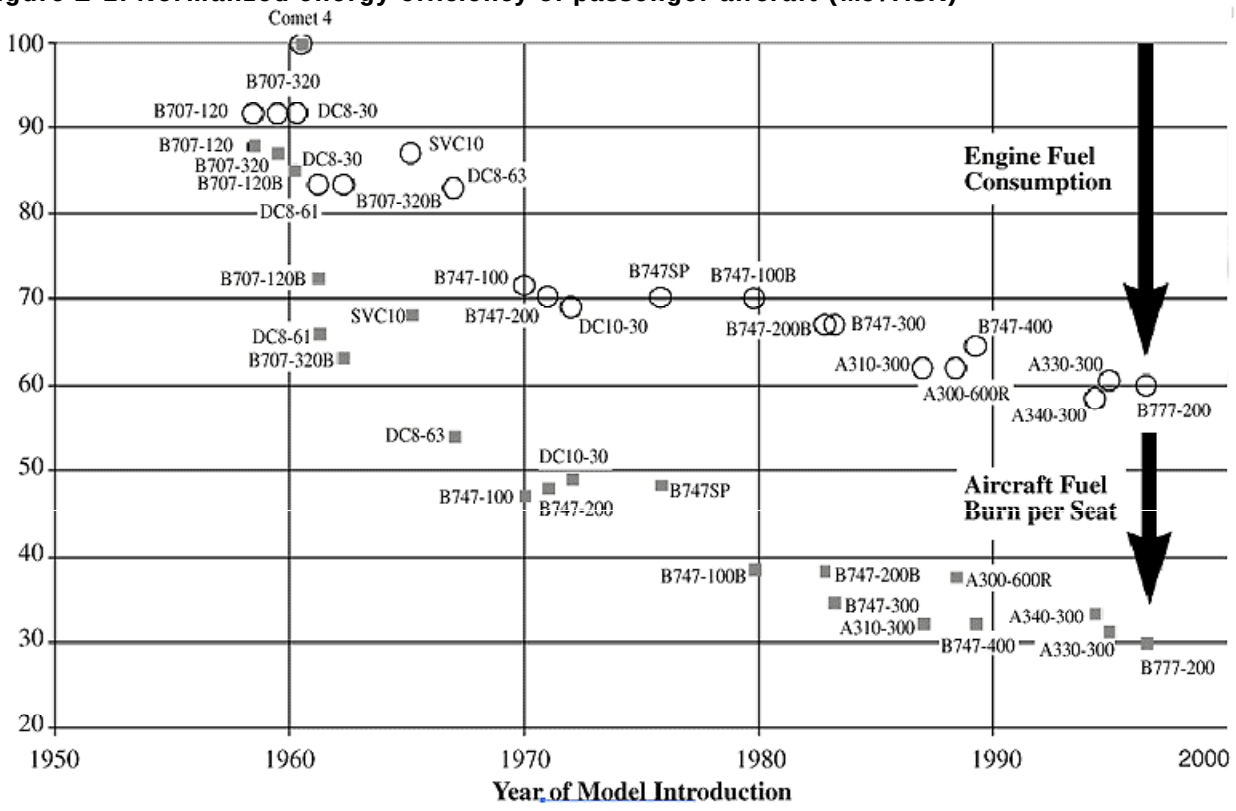
Figure E-1. History of fuel charges



Source: DOT BTS
http://www.transtats.bts.gov/rtm91_02.htm

The consumption of fuel of an aircraft is dependent on four factors, the length of the route, the weight of the aircraft, the efficiency of the engines, and the share of the airframe. The length of the route has two impacts on fuel consumption. The first relates to fuel consumed at the cruising altitude, which is directly

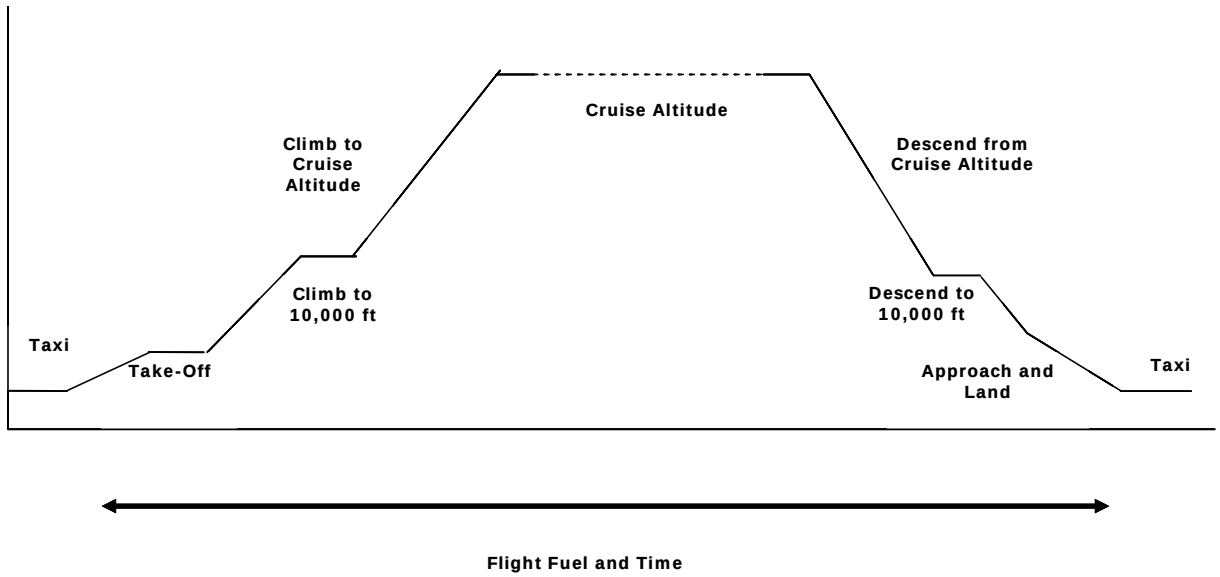
Figure E-2. Normalized energy efficiency of passenger aircraft (MJ/ASK)



Source: IPCC 1999, http://www.grida.no/climate/ipcc/aviation/133.htm#img93

proportional to the distance traveled. This distance will include the direct route plus any diversions due to weather of traffic congestion. The second relates to the fuel consumed taxiing to and from the terminal, climbing to the cruise altitude and descending from cruise altitude including any time spent in a holding pattern waiting to land (Figure E-3). A significant amount of fuel is consumed during these operations, especially relative to the distance traveled. The impact is greatest for short trip where ¼ to 1/3 of the fuel for a trip may be consumed in these operations. The impact diminishes with the length of the trip and beyond 4–6 thousand kilometers contributes less than 10 percent. Therefore, for intercontinental or longer regional flights, the fuel consumption can be estimated as proportional to the distance traveled.

Figure E-3. Typical flight plan



The shape of the airframe determines not only the carrying capacity of the aircraft but also its aerodynamic drag. Aircraft drag is the sum of zero-lift drag and induced drag due to lift. The former is the sum of drag due to skin friction and pressure. The skin friction occurs at the boundary layer as a result of the viscosity of the air and depends on whether the flow is laminar or turbulent. This drag varies with the shape of the airframe and the speed of travel. Pressure drag depends on the thickness of the boundary layer, which affects pressure recovery at the trailing edge. This is relatively small for subsonic flight. Drag due to lift has two components; induced and viscous. The former is vortex drag, which depends on the distribution of lift across the span of an aircraft. The latter is due to the increase in the boundary layer with the angle of attack.

At a given speed, an increase aircraft weight will increase drag because of changes in the wing to generate sufficient lift. However, the marginal impact is insignificant compared to the impact that an increase in weight has on lift. A more significant impact is the effect of weight on cruising altitude. The heavier the weight, the lower the cruising altitude because the plane requires sufficient air density to provide the necessary lift. The more dense the air, the greater the impact of draft. Thus for our purposes, the increase in thrust and resulting increase in fuel required can be treated as a function of total aircraft weight.

Fuel is consumed while providing the thrust necessary to overcome this drag. The drag in turn depends on the speed of the aircraft. In the last two decades, significant improvements have been

made in reducing draft through changes in the shape of the wing. The aircraft are designed to operate in a specific speed range at cruising altitude so that the drag does not vary due to speed.

Aerodynamic efficiencies of large aircraft have improved approximately 15 percent since 1959 (Lee *et al*., 2001). Most of these gains were realized after 1980 through better wing design and improved propulsion/airframe integration made possible by improved computational and experimental techniques (IPCC, 1999). Advanced materials such as improved aluminum alloys and composites have been successfully used for control surfaces, flaps, and slats on civil aircraft. However, the current fleet of aircraft is still about 97 percent metallic, with composites used only on relatively few components such as the tail. Furthermore, structural weight reductions have been offset by structural weight increases to enable improvements in aerodynamics and accommodate increased engine weights (IPCC, 1999).

The SAR (Specific air range) model[50] is the basic model for describing the physics of aircraft in steady cruise flight, and it quantifies the distance flown per unit of energy consumed. By inverting the equation, the fuel consumption per unit distance is proportional to.

$$\frac{1}{W} * \frac{D * TFSC}{L * V}$$

where:

W = $W_{fuel} + W_{payload} + W_{structure} + W_{reserve}$ of the aircraft

D = drag coefficient for the airframe

L = lift coefficient for the airframe

V = velocity

TSFC = Thrust specific fuel consumption per unit time for the engine

The payload an aircraft is carrying does not have a direct impact on the drag. There will be a slight adjustment in the wing to provide greater lift for heavier payloads but the effect on drag and thus fuel consumption is minimal. A significant increase in payload has a secondary impact on drag because it lowers the cruising altitude in order to provide sufficient air density to provide the necessary lift. The higher density air increases the drag. Therefore, for a given aircraft operating at its cruising altitude, the fuel consumed to overcome drag will be relatively constant regardless of the payload, but the fuel consumption will change along with the optimum cruising altitude for substantial differences in payload.

The efficiency of the engines on the aircraft has a direct impact on fuel consumption. Propulsive efficiencies improved significantly with the introduction of the high-bypass ratio engine. Initially developed for long haul, wide-body aircraft, high-bypass ratio engines contributed to the noticeable increase in fuel efficiency in the early 1970s. However, these engines were not installed on smaller aircraft until more than a decade later. The DC-9-80 and the 737-300 introduced in the first half of the 1980s were still equipped with low-bypass engines.

The loaded weight of the aircraft has a direct relation to the amount of fuel consumed at cruising altitude because of the thrust required to provide the required lift. Ignoring the impact of drag, the

[50] $SAR = \frac{Velocity}{TSFC \times h_F} \times \frac{L}{DW}$ where h_F =heating value of jet fuel

fuel consumed per kilometer is directly proportional to the full weight of the aircraft. Since that weight diminishes as fuel is consumed during flight, the rate of fuel consumption will gradually decrease over the length of a flight. The longer the flight, the higher the average rate of fuel consumption because the greater the fuel that must be carried. Similarly, the greater the payload, the more the fuel that must be carried because of the need for additional lift.

Table E-1. Sources of fuel efficiency

Source	Average Annual Improvement
Engine efficiency	1.0%
Aerodynamics	0,4%
Airframe Weight	0.5%-1.0%
Operations, Load Factor	0.3%

Source: ref. Babikan

The combined impact of improvements in technology based on past trends suggests an average annual increase in aircraft fuel efficiency of 2–2.5 percent as shown in Table E-1. The improvement in engine efficiency will derive from advancements already introduced for passenger aircraft that will be converted to freighters in the future as well as the introduction of ultra-high bypass engines. These improvements apply to long-range flights. The shorter flights would show less improvement. The reduction in airframe weight is expected to result from the increase in use of composite materials which will take place in the passenger aircraft over the next 10-15 years and in the air cargo business beginning with new aircraft but accelerating in 15 years when the conversions of passenger aircraft.

The impact on fuel consumption of a change in payload requires an evaluation of both the relationship of aircraft weight to fuel consumption at cruising speed and the change in aircraft weight with a change in payload for a specific route. The first can be addressed using the Brequet range equation, which extends the SAR to include the weight of fuel consumed for steady cruise flight over a specific range.

$$R = \frac{V\left(L/D\right)}{g\ SFC} \ln\left[1 + \frac{W_{fuel}}{W_{airframe} + W_{payload} + W_{fuel\ reserve}}\right]$$

Where
V = Cruising velocity
L/D = lift to drag coefficient
SFC = fuel consumption per unit thrust
g = gravity constant
W_{fuel} = Weight of fuel consumed during flight
$W_{reserve}$ = weight of required fuel reserves

This equation takes into consideration the variation in weight as the fuel is consumed during the flight.

By moving terms the equation becomes

$$R\frac{g\ SFC}{V\left(L/D\right)} = \ln\left[1 + \frac{W_{fuel}}{W_{airframe} + W_{payload} + W_{fuel\ reserve}}\right]$$

By setting the distribution constant, R_o, introducing the exponent and reversing terms, the equation becomes

$$W_{fuel} = \left(W_o + W_{payload}\right)\left(e^{\alpha R_o} - 1\right)$$

Where

$$\alpha = \frac{g\ SFC}{V\left(L/D\right)}$$

$$W_o = W_{airframe} + W_{fuel\ reserve}$$

Assuming that α is constant and differentiating equation (3) yields the following relation

$$\frac{\partial W_{fuel}}{\partial W_{payload}} = e^{\alpha R_o} - 1$$

This implies that a uniform amount of fuel is required for each additional ton of payload.

ANNEX F. FREIGHT FORWARDERS

While air carriers – for obvious reasons – draw the lion's share of attention, freight forwarders and other allied services fill critical roles in the development of air cargo operations. In many developing markets, freight forwarders either supplement or wholly replace the carrier's own in-country sales efforts, while also performing customs brokerage and other critical functions on behalf of shippers.

Many smaller forwarders have been eliminated or acquired by larger forwarders, while some acquisition targets previously ranked among the industry's largest players. Perusing a list of 2005 largest freight forwarders (Table F-1), some of the more notable acquisitions/consolidations have included: #1 Danzas acquiring #3 Exel and #22 ABX Logistics; Deutsche Bahn acquiring #4 BAX Global and #6 Schenker; #12 UPS moved up from #16 after acquiring former #12 Menlo.

Table F-1. Top IATA freight forwarders ranked by global forwarding revenues, 2005

Rank 2005	Company	2005 US $ million	2005 Share
1	DHL Danzas	2,097	7.92%
2	Nippon Express	1,263	4.96%
3	Exel	1,086	4.27%
4	BAX Global	887	3.49%
5	Kuehne & Nagel	814	3.20%
6	Schenker	767	3.01%
7	Expeditors	753	2.96%
8	Panalpina	666	2.62%
9	Kintetsu	649	2.55%
10	Yusen	631	2.48%
11	EGL Eagle	538	2.11%
12	UPS[51]	457	1.80%
13	UT	336	1.32%
14	Hellmann	298	1.17%
15	Geologistics	277	1.09%
16	Shanghai Jin Hai Jet Air	264	1.04%
17	Hankyu	262	1.03%
18	Speedmark	211	0.83%
19	SDV	208	0.82%
20	Nishi Nippon Railroad	198	0.78%
21	United China Airfreight	190	0.75%
22	ABX Logistics	160	0.63%

Source: International Air Transport Association

In many developing markets, the trend for national forwarders was to retain substantial market shares, as well as independence of ownership – rather than being absorbed into the mega-forwarders that uniformly dominate industrialized markets. Forwarders based in developing markets rarely expanded their clientele into industrialized nations. Often, major forwarders established "agency relationships" with forwarders in developing countries (and even in major foreign markets) to handle

[51] Ranking is based solely on UPS' forwarding revenues. IATA has registered its belief that its revenue and consequent market shares have been undercounted – especially as it ranked #10 in the previous year.

in-country affairs on behalf of their clients. Occasionally, these partnerships would lead to a later acquisition.

Latin America

Among the top ten forwarders in Latin America, only one – Colombian company Interandina Internacional – is actually based in the region. Repeating the theme of industry consolidation yet again, #1 DHL acquired #7 Exel, while Deutsche Bahn acquired both #4 BAX Global and #9 Schenker.

Table F-2. Top 10 air forwarders in Latin America, 2005 (by annual cargo spends)

Rank	Company Name	US$ millions
1	DHL/Danzas	111.20
2	Panalpina	57.25
3	EGL Eagle Logistics	45.63
4	BAX Global	34.14
5	UPS	24.55
6	Interandina Internacional	18.66
7	Exel Global Logistics	17.24
8	Kuehne & Nagel	17.03
9	Schenker	16.18
10	Expeditors	13.14

Source: IATA CASS data

While the impression drawn from the preceding table is of a region dominated by multinational forwarders, subtle differences arise when individual country-markets are considered. Much of the regional difference is based upon the multinationals' cumulative revenues from a variety of individual countries, while the major forwarders actually based in Latin America tend to be major players only in their country of origin – but can often compete favorably against the global players in those markets.

For example, six of the ten largest forwarders in Colombia were based in that country – including #1 Interandina Internacional and #2 Transandina de Carga. Similarly, Panalpina was the only multinational freight forwarder to even rank (#9) among the top ten forwarders in Ecuador. At least between Latin America's two biggest exporting markets of cut flowers, a marked preference for local forwarders has been upheld, also likely reflecting the specialized care and generations-old relationships common to that industry.

On the other hand – and perhaps demonstrating the priorities of the global forwarders – by far the largest individual market in Latin America (Brazil) is dominated by multinationals with DHL, Panalpina, EGL Eagle Logistics and UPS ranking #1 through #4 in the market. Schenker and Exel also rank in the top seven, along with the only non-multinational, #5 Logimasters. Similarly, DHL, BAX Global and EGL Eagle rank #1 through #3 in Chile.

Africa

Compared with Latin America, where the major multinational forwarders have placed significant markers in the largest country markets, their impact in Africa has been relatively less substantial. In Africa, the multinational players tend to be extensions of the old colonial influences rather than the largest global players so dominant in the industrialized regions and major developing markets. Also contrasting with Latin America where U.S.-based forwarders and integrators remain very important,

U.S. forwarders are virtually irrelevant in Africa when compared with the French SDV, Swiss Kuehne & Nagel (K&N) and German DHL.

SDV ranks only #19 in the world but competes with DHL and K&N as leading multinational forwarders in Africa. SDV is the only significant air forwarder in Mali, ranks #2 in Cote d'Ivoire, #3 in Mauritius, #4 in Senegal and #8 in Kenya. Swiss K&N ranks #1 in the very important Kenyan market with almost three times the revenues of the second largest forwarder, as well as ranks #5 in South Africa. While perhaps not having as diversified an African portfolio as SDV, K&N's much larger profile in two of Africa's most important markets more than overtakes SDV's superior performance in a number of smaller markets. By comparison, DHL ranks #3 in South Africa and #9 in Egypt.

As with some Latin American markets, national forwarders still retain substantial roles in Africa – either as entirely independent entities or as independent agents acting in concert with a variety of multinational forwarders unwilling or incapable of establishing local operations. For example, the important Egyptian market is dominated by Egyptian air forwarder Venus International Transport, which commands more than four times the annual revenue of Egypt's second largest forwarder, another Egyptian firm Sinai International. Similarly, South Africa's largest forwarders are national entities, Pyramid Freight and Grindrod Perishable – both ranking ahead of #3 DHL in that market.

Asia

CASS data provides a useful broad overview but far from pinpoint accuracy with rankings dependent upon self-reporting. Only three Asia-based forwarders rank among the top ten regional forwarders – Japanese forwarders Nippon Express, Kintetsu World Express and Yusen Air & Sea Service. The balance of ranking forwarders are mostly European-based, albeit the extraordinary market penetration of BAX Global throughout Asia was developed during its decades as a U.S. entity. Much the same could be said for the DHL portion of the DHL/Danzas empire. Indeed, the mega-forwarders are much in evidence among the leading forwarders in Asia, with the BAX Global/Schenker combine ranking #4 and #9, and DHL/Exel taking positions #2 and #3. Swiss forwarders Kuehne & Nagel and Panalpina and U.S. forwarder Expeditors International also ranked in the top ten.

As with other regions, the global forwarders have concentrated their efforts on the largest markets, while achieving far less dominance in smaller developing markets. Individual top ten rankings for Hong Kong and Singapore are very similar to the regional rankings above. Although a large market with increasing presence from global cargo operators (often through acquisitions and partnerships with national entities), India still has a substantial presence of national forwarders, led by #1 Leaap Forwarders, #4 Expo Freight, #8 Continental Carriers and #10 Jeena & Co. Thailand also has several leading national forwarders, including #1 Trans Air Cargo, #2 Multi Air Services and #3 Thai Master Transport. Revealing much about how the global forwarders perceive which markets constitute "low-hanging fruit", only two Japanese firms (Yusen Air & Sea Service and Nippon Express) rank among Indonesia's top ten with the balance all being Indonesian interests, led by #1 Cardig Express and #2 Global Putra.

Table F-3. Top 10 air forwarders in Asia, 2005 (by annual cargo spends)

Rank	Company Name	US$ millions
1	Nippon Express	1,135.87
2	Exel	684.37
3	DHL Logistics	676.38
4	BAX Global	658.91
5	Kintetsu World Express	636.72
6	Yusen Air & Sea Service	627.90
7	Expeditors	515.28
8	Kuehne & Nagel	393.45
9	Schenker	379.24
10	Panalpina	314.52

Source: IATA CASS data

The Pros & Cons of Global Forwarders

While the extent to which developing markets are disadvantaged by a dearth of dominating global forwarders may be partially debatable, that such operators can contribute to larger trade development efforts has been demonstrated in practice. In a global economy, service levels somewhat reflect demand, although distorted by political unrest and protectionism that constrain foreign entities. Too, some perishables exporters in developing countries maintain their consignments are so sensitive that shippers are disinclined to 'shop' for new service-providers to supplant 'tried and true' vendors who may have provided such services to the same enterprises for generations. While the preceding experience pertains more to an 'operational capability', shippers in many developing countries also suggest that national forwarders and customs brokers are far more *nimble* in their ability to *smooth* regulatory hitches occurring with disagreeable Customs, Agriculture and other inspection agencies. National forwarders may often enjoy uniquely strong relationships with national carriers, thereby gaining access for their customers to the precious limited capacity of such carriers during peak seasons.

Table F-4. Cargo 2000 industry associate members

Forwarders
ABX
Agility
DHL Danzas
Hellmann
Kuehne & Nagel
Panalpina
Schenker AG
SDV
TNT Freight Management
Trans-Trade
Uti
Yusen

The preceding narrative qualifies the benefit to local shippers from the entry of global forwarders into a developing market, yet in no way diminishes an underlying belief that shippers largely benefit from the introduction of such ‘gold level’ services. The following table lists freight forwarders that have already agreed to implement standards compliant with IATA’s Cargo 2000 program.

Not only does the quality of forwarder service rise, but also forwarders offer at least the potential to grow capacity offered by carriers to whom large forwarders may have particularly strong relationships. Forwarders are critical to carriers in markets in which foreign carriers (particularly passenger carriers for whom cargo is treated as a mere bi-product) are less inclined to maintain their own sales forces. Larger forwarders control sufficient volumes to influence the routing decisions of freighter operators working in collaboration, as Swiss forwarder Panalpina often does with Luxembourg carrier Cargolux.

Global freight forwarders are almost uniformly multi-modal, and markets with large seaports enjoy a competitive advantage in attracting and/or sustaining a larger base of forwarders due to the ability to book sea freight, as well. Conversely, land-locked markets may be at a disadvantage to attract such operators due to the inability to leverage seagoing cargo – usually in far greater volumes than that transported by air.

ANNEX G. AIR CARGO VILLAGE

The term 'Air Cargo Village' has been applied to such a broad – both in scale and in services - array of conditions as to become almost meaningless. Ideally, the term invokes the gains of efficiency represented by collocating the cargo operations of airlines (both passenger and cargo), freight forwarders, ground-handlers, trucking (both local delivery and linehaul) and federal inspections. In some sense, the 'cargo village' may be one single multi-tenant building with warehouse operations on the ground level and offices located on floors above or also on ground level but perhaps not having airside access. Alternatively, the 'cargo village' may be a collection of buildings – which cumulatively may or may not represent all of the airport's critical air cargo functions. For example, some so-called cargo villages may not include belly-cargo operations which may be collocated with the rest of the passenger operations or may exclude the operating space of integrated carriers which tend to operate in much more of a 'closed-loop', rather than requiring the ground-handling and trucking services of third-parties.

The tangible benefit of a cargo village configuration is far from absolute. Intuitively one believes that having all of these services in one general area should promote efficiency – not least from improved communications. However, small (in terms of tonnage and operations) cargo airports are far more likely to have all of their commercial cargo operations in one site – simply because the local operating scale can easily be accommodated in one place. Alternatively, some major cargo airports – such as New York JFK and Los Angeles International Airport – have cargo operations spread around the airfield, as well as off-airport. Neither airport operator would suggest that having such spread out cargo operations is optimal. Movements of ground services equipment, gate utilization and security concerns are certainly complicated by such divergence. Yet one could hardly contemplate the success of either airport and establish that such conditions had prevented them from joining the top tier of cargo airports.

As with so much throughout this study, the consequences of the presence/lack of a discernible 'cargo village' seems to be driven by market context. Newer airports – such as Dubai International Airport – that were able to create cargo villages without displacing decades of other development have undoubtedly benefited. Yet, legacy airports at which cargo operations were essentially 'jammed' into any available gap in the airports' footprint have retained their utility because cargo operators were willing to tolerate less than optimal conditions to exploit the superior frequencies, destinations and selection of carriers available.

In many developing countries, the presence of a cargo village is likely to be beneficial operationally but whether such a resource would lead to increases in operating volumes is highly debatable. What is most important is whether the market can justify the attraction/retention of carriers and forwarders, regardless of whether these can be tidily collocated in a single facility or area. The processing of large volumes necessarily applies pressure on efficiency that often does not exist with smaller volumes – which can occasionally be processed in acceptable time increments even in the face of numerous sub-optimal practices and resources. The benefit of a 'cargo village' may be greatest for airports that already have large-scale operations – which, paradoxically, in Europe and North America at least tend to be airports subject to the most 'vintage' development and therefore are least likely to have large plots of available contiguous space.

Amsterdam Schiphol is one successful airport that clearly believes in the benefits of the cargo village approach, which is a prominent feature in the airport's new long-term master plan. Schiphol is actively trying to attract freight forwarders back on-airport into a proposed development that would

collocate forwarders and ground-handlers with on-ramp access to allow large forwarders to take pre-built pallets and containers directly onto the ramp. The plan also entails enhanced accommodations for trucking companies and longer-term, the establishment of air-intensive shippers, such as mobile phones and other high-value, time-definite electronics.

Sea-Air Intermodal Transport

In his 2005 book **Transport Logistics: Past, Present And Predictions**,[52] Swift Freight Group Chairman & CEO Issa Baluch described the origins of the sea-air model as owing to the need for airlines to leverage underutilized capacity on international scheduled routes. Specifically, Baluch cited the United Arab Emirates in the 1970's wherein inbound flights fed the booming oil industry but often left empty. As Baluch explained, what was initially 'fill-in' cargo developed into a product unto itself.

Interviewed for this study, the cargo manager of a major Middle Eastern air carrier reported that although sea/air was a small percentage of the carrier's total volume, it has become a critical element of supply chain management for those companies for whose business it is applicable. For one example, he cited mobile phones for which the life cycle of individual models may only be six months to one year. With such a short life cycle, all R&D costs must be amortized over the first batch of production. The first wave may be transported by air (transportation time of 2—4 days), the second by a combination of air and sea (transportation time of 15—17 days) and the third transported totally by sea (30—40 days).

The cargo will be transported from Customs clearance directly to retail shelves. By the time that the first batch has been sold, the second wave has arrived and so on through the third wave. This methodology allows sellers to avoid holding inventory and related costs therein. Moreover, as slower, cheaper modes (and combinations of modes) are employed, individual unit costs go down which allows for discounting on subsequent waves – a relatively common practice with electronics.

While products originating in developing countries may be fed into sea/air combinations, the important conversion points – Dubai & Sharjah in the United Arab Emirates, Seattle and Vancouver in North America and Singapore in Asia – are in industrialized markets. Undoubtedly the competitive advantage of these sites stems from superior seaport and airport connectivity – neither of which (let alone both) is common to most developing markets, especially the air service.

Sea-air entails a compromise between cheaper, slower sea and more expensive, faster air transport. In his book, Baluch observed that the ideal sea-air hub must sit approximately midway between origin and destination, and the airfreight cost should not amount to more than 50 percent of the direct airfreight cost from origin to destination.

Sharjah

In 2005, Sharjah International Airport accounted for approximately twice the cargo volume of Abu Dhabi International Airport but less than half as much as Dubai. Sharjah formerly was Lufthansa Cargo's largest operation outside of Germany, supported by a cargo-swap program with Singapore Airlines and cargo feeders into India.

Table G-1. Sharjah: 2005 cargo distribution

Exports	128,416	25.4%
Imports	65,175	12.9%
Sea/Air	52,238	10.3%
Transit	275,920	54.6%

Source: Sharjah airport website

[52] Winning Books, www.transportlogistics.com

However, Lufthansa has since routed all of its Japan and China flights over Astana, Kazakhstan but Sharjah remains the principal stop for Lufthansa's operations to Hong Kong and Southeast Asia. Lufthansa also runs one of the airport's cargo terminals. Sharjah is also served by scheduled freighters of Singapore Airlines, Cargolux, Martinair and Egyptair, as well as a host of charter operators. Sharjah is the hub of low-fare Air Arabia, but its narrow-body Airbus 320 fleet is not conducive to significant belly cargo operations.

Sea-Air is a significant growth business for Sharjah, having risen 47 percent in 2005 to 52,238 tons (roughly 10 percent of total cargo for the year). The Indian subcontinent is responsible for much of the Sea-Air business to Europe.

Sea transport as competition

For many years, cargo operators have contemplated the potential (but unrealized) competitive threat of FastShips that cross oceans in one-fourth or less of current durations: the Atlantic in four days and the Pacific in six. Less ambitious (shorter) distances have already experienced diversions from air to sea as Customs delays in some developing countries diminished the competitive advantage of more expensive, ostensibly quicker air transport. More recently, fuel costs and more efficient trucking operations have already caused diversions from air to surface transport.

ANNEX H. SHELF LIFE FOR FRESH FRUITS AND VEGETABLES

Table H-1. Time sensitive fruits and vegetables

	Days		Weeks
Bean sprouts	7-9	Apricots	1-3
Beans, Green, Snap	7-10	Artichokes	2-3
Beans, Lima in pods	5	Avocado, Lula	2
Broccoli	10-14	Banana, green	1-4
Cantaloupes	5-14	Blueberries	2
Chard	10-14	Bok choy	3
Cherries, sour	10-14	Carrots, bunched	2
Chinese long bean	7-10	Cherries, sweet	2-3
Chinese broccoli	10-14	Grapes, America	2-8
Collards	10-14	Green Peas	1-2
Cucumbers	10-14	Guavas	2-3
Dewberries	2-3	Jackfruit	2-6
Eggplant	7	Lettuce	2-3
Figs, Fresh	7-10	Mangoes	2-3
Elderberries	7	Melons	2-3
Greens, leafy	10-14	Orange, Jaffa	2-8
Loganberries	2-3	Orange, Calif	3-8
Mushrooms	3-4	Papaya	1-3
Raspberries	2-3	Sweet Peppers	2-3
Snow Peas	10-14	Rambutan	1-3
Strawberries	5-7	Squash, summer	1-2
Tomatoes, ripe	4-7	Tomatoes, mature green	1-3
		Tangerine, mandarin	2-4

Source: USDA, "Tropical Products Transport Handbook, 1987

Table H-2. Fruits and vegetables stored at temperature 0-5^{0}C

Anise, Apple, Asparagus, Bean sprout, Belgian endive, Bok Choy, Broccoli, Brussels sprouts, Cabbage, Calabasas, Cantaloupe, Carrots, Cauliflower, Celery, Sour Cherries, Clementine, Coconuts, Sweet corn, Cranberries, Endive, Leafy greens, Kale, Kiwifruit, Kumquats, Leeks, Lettuce, Longan, Loquat, Lychee, Mushroom, Onion, Green peas, Pomegranate, Radishes, Rhubarb, Snow peas, Spinach, Strawberries, Tamarillos, Tamarind, Turnips, Water chestnuts, Watercress

Source: USDA, "Tropical Products Transport Handbook, 1987

ANNEX I. AIR FREIGHTERS THROUGH TIME

Figure Bristol MK31 Freighter – 1940s

164 mph cruise, Span 108 feet, Length 68 feet

Douglas DC-3 – 1950s

237 mph, Span 95 feet, length 65 feet

Antonov – 1960s

485 mph, Span 125 feet, Length 109 feet, 20

Iluyshin – 76 – 1970s

560 mph, Span 165 feet, Length 152 feet, 47 tons

Antonov 225 – 1980s

465 mph, Span 290 feet, Length 275 feet, 250 tons

Boeing 777 F – 1990s

Boeing 747F – 1990s

560 mph, Span 211 feet, Length 231 feet, 110 tons

MD-11 – 1990s

544 mph, Span 170 feet, Length 201 feet, 90 tons

Antonov 72 – 1980s

Span 104 feet, length 92 feet, 10 tons

Antonov 124 – 1980s

Speed 537 mph, Span 240 feet, Length 226 feet, 264 tons

Airbus Beluga – 1990s

Span 147 feet, Length 184 feet, 103 tons

Loading Antonov 124

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Antonov 124 – 1980s
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Airbus Beluga – 1990s

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