**Amazon Distribution Problem**

Amazon.com is a major online retailer and has transitioned in recent years to a logistics company even more than a retail giant. Amazon Air began operations in 2015 with 20 leased aircraft and in 2018 leased an additional 10 aircraft for a total of 30. By 2020, Amazon Air had leased a total of 50 aircraft. At present, Amazon Air has a main cargo hub at Cincinnati/Northern Kentucky International Airport and a regional air hub at Fort Worth Alliance Airport.

From these two hubs, aircraft deliver packages to fulfillment centers located outside of their local line-haul network. There are 68 such centers, of which 3 are called *focus cities*. All the centers that are not focus cities (65) may receive cargo directly from one of the hubs or the focus cities.

Each center city has a total cargo demand to satisfy Amazon customers in those cities. Those are found below in Table 1. The hubs and focus cities also have capacity limits to the total amount of cargo that can be shipped through them every month. Those are also shown in Table 1.

**Table 1. Demand and capacity for all cities per month (in tons)**

|  |  |  |
| --- | --- | --- |
| **Hubs** |  |  |
| **City** | **Current tons** | **Capacity (monthly tons)** |
| Cincinnati/Northern Kentucky (CVG) | 82,800 | 95,650 |
| Alliance Fort Worth (AFW) | 38,400 | 44,350 |

|  |  |  |
| --- | --- | --- |
| **Focus Cities** |  |  |
| **City** | **Airport** | **Capacity (monthly tons)** |
| Leipzig | Leipzig/Halle Airport | 85,000 |
| Hyderabad | Rajiv Gandhi International Airport | 19,000 |
| San Bernardino | San Bernardino International Airport | 36,000 |

|  |  |  |
| --- | --- | --- |
| **Centers** |  |  |
| **Country** | **City** | **Demand (monthly tons)** |
| France | Paris | 6,500 |
| Germany | Cologne | 640 |
| Germany | Hanover | 180 |
| India | Bangalore | 9,100 |
| India | Coimbatore | 570 |
| India | Delhi | 19,000 |
| India | Mumbai | 14,800 |
| Italy | Cagliari | 90 |
| Italy | Catania | 185 |
| Italy | Milan | 800 |
| Italy | Rome | 1,700 |
| Poland | Katowice | 170 |
| Spain | Barcelona | 2,800 |
| Spain | Madrid | 3,700 |
| United Kingdom | Castle Donington | 30 |
| United Kingdom | London | 6,700 |
| United States (Alabama) | Mobile | 190 |
| United States (Alaska) | Anchorage | 175 |
| United States (Alaska) | Fairbanks | 38 |
| United States (Arizona) | Phoenix | 2,400 |
| United States (California) | Los Angeles | 7,200 |
| United States (California) | Ontario | 100 |
| United States (California) | Riverside | 1,200 |
| United States (California) | Sacramento | 1,100 |
| United States (California) | San Francisco | 1,900 |
| United States (California) | Stockton | 240 |
| United States (Colorado) | Denver | 1,500 |
| United States (Connecticut) | Hartford | 540 |
| United States (Florida) | Miami | 3,400 |
| United States (Florida) | Lakeland | 185 |
| United States (Florida) | Tampa | 1,600 |
| United States (Georgia) | Atlanta | 3,000 |
| United States (Hawaii) | Honolulu | 500 |
| United States (Hawaii) | Kahului/Maui | 16 |
| United States (Hawaii) | Kona | 63 |
| United States (Illinois) | Chicago | 5,100 |
| United States (Illinois) | Rockford | 172 |
| United States (Indiana) | Fort Wayne | 200 |
| United States (Indiana) | South Bend | 173 |
| United States (Iowa) | Des Moines | 300 |
| United States (Kansas) | Wichita | 290 |
| United States (Louisiana) | New Orleans | 550 |
| United States (Maryland) | Baltimore | 1,300 |
| United States (Minnesota) | Minneapolis | 1,700 |
| United States (Missouri) | Kansas City | 975 |
| United States (Missouri) | St. Louis | 1,200 |
| United States (Nebraska) | Omaha | 480 |
| United States (New Hampshire) | Manchester | 100 |
| United States (New Mexico) | Albuquerque | 450 |
| United States (New York) | New York | 11,200 |
| United States (North Carolina) | Charlotte | 900 |
| United States (Ohio) | Toledo | 290 |
| United States (Ohio) | Wilmington | 150 |
| United States (Oregon) | Portland | 1,200 |
| United States (Pennsylvania) | Allentown | 420 |
| United States (Pennsylvania) | Pittsburgh | 1,000 |
| United States (Puerto Rico) | San Juan | 1,100 |
| United States (Tennessee) | Nashville | 650 |
| United States (Texas) | Austin | 975 |
| United States (Texas) | Dallas | 3,300 |
| United States (Texas) | Houston | 3,300 |
| United States (Texas) | San Antonio | 1,100 |
| United States (Virginia) | Richmond | 600 |
| United States (Washington) | Seattle/Tacoma | 2,000 |
| United States (Washington) | Spokane | 260 |

The distribution costs between each focus and center city are known and are shown in Table 2.

**Table 2. Distribution costs from hubs and focus cities to centers**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***Suppliers*** | Cincinnati/ Northern Kentucky hub | Alliance  Fort Worth hub | Leipzig  focus city | Hyderabad focus city | San Bernadino focus city |
| Leipzig | 1.5 | N/A | N/A | N/A | N/A |
| Hyderabad | N/A | N/A | 1.6 | N/A | N/A |
| San Bernardino | 0.5 | 0.5 | N/A | N/A | N/A |
| Paris | 1.6 | N/A | 0.5 | 1.1 | N/A |
| Cologne | 1.5 | N/A | 0.5 | 1 | N/A |
| Hanover | 1.5 | N/A | 0.5 | 1 | N/A |
| Bengaluru | N/A | N/A | 1.5 | 0.5 | N/A |
| Coimbatore | N/A | N/A | 1.5 | 0.5 | N/A |
| Delhi | N/A | N/A | 1.5 | 0.5 | N/A |
| Mumbai | N/A | N/A | 1.5 | 0.5 | N/A |
| Cagliari | 1.5 | N/A | 0.5 | 1 | N/A |
| Catania | 1.5 | N/A | 0.5 | 1 | N/A |
| Milan | 1.5 | N/A | 0.5 | 1 | N/A |
| Rome | 1.5 | N/A | 0.5 | 1.1 | N/A |
| Katowice | 1.4 | N/A | 0.5 | 1 | N/A |
| Barcelona | 1.5 | N/A | 0.5 | 1 | N/A |
| Madrid | 1.6 | N/A | 0.5 | 1.1 | N/A |
| Castle Donington | 1.4 | N/A | 0.5 | N/A | N/A |
| London | 1.6 | N/A | 0.75 | 1.1 | N/A |
| Mobile | 0.5 | 0.5 | N/A | N/A | 0.5 |
| Anchorage | 1.3 | 1 | N/A | N/A | 0.7 |
| Fairbanks | 1.4 | 1 | N/A | N/A | 0.7 |
| Phoenix | 0.5 | 0.5 | N/A | N/A | 0.5 |
| Los Angeles | 0.5 | 0.5 | N/A | N/A | N/A |
| Ontario | 0.5 | 0.5 | N/A | N/A | N/A |
| Riverside | 0.5 | 0.5 | N/A | N/A | N/A |
| Sacramento | 0.5 | 0.5 | N/A | N/A | 0.5 |
| San Francisco | 0.5 | 0.5 | N/A | N/A | 0.5 |
| Stockton | 0.5 | 0.5 | N/A | N/A | 0.5 |
| Denver | 0.5 | 0.5 | N/A | N/A | 0.5 |
| Hartford | 0.5 | 0.5 | 1.5 | N/A | 0.5 |
| Miami | 0.5 | 0.5 | N/A | N/A | 0.7 |
| Lakeland | 0.5 | 0.5 | N/A | N/A | 0.7 |
| Tampa | 0.5 | 0.5 | N/A | N/A | 0.7 |
| Atlanta | 0.5 | 0.5 | N/A | N/A | 0.6 |
| Honolulu | N/A | 0.5 | N/A | N/A | 0.5 |
| Kahului/Maui | N/A | 0.5 | N/A | N/A | 0.5 |
| Kona | N/A | 0.5 | N/A | N/A | 0.5 |
| Chicago | 0.5 | 0.5 | N/A | N/A | 0.5 |
| Chicago/Rockford | 0.5 | 0.5 | N/A | N/A | 0.5 |
| Fort Wayne | 0.5 | 0.5 | N/A | N/A | 0.5 |
| South Bend | 0.5 | 0.5 | N/A | N/A | 0.5 |
| Des Moines | 0.5 | 0.5 | N/A | N/A | 0.5 |
| Wichita | 0.5 | 0.5 | N/A | N/A | 0.5 |
| New Orleans | 0.5 | 0.5 | N/A | N/A | 0.5 |
| Baltimore | 0.5 | 0.5 | 1.5 | N/A | 0.7 |
| Minneapolis | 0.5 | 0.5 | N/A | N/A | 0.5 |
| Kansas City | 0.5 | 0.5 | N/A | N/A | 0.5 |
| St. Louis | 0.5 | 0.5 | N/A | N/A | 0.5 |
| Omaha | 0.5 | 0.5 | N/A | N/A | 0.5 |
| Manchester | 0.5 | 0.5 | 1.5 | N/A | 0.7 |
| Albuquerque | 0.5 | 0.5 | N/A | N/A | 0.5 |
| New York | 0.5 | 0.5 | 1.6 | N/A | 0.7 |
| Charlotte | 0.5 | 0.5 | N/A | N/A | 0.7 |
| Toledo | 0.5 | 0.5 | N/A | N/A | 0.5 |
| Wilmington | 0.5 | 0.5 | N/A | N/A | 0.7 |
| Portland | 0.5 | 0.5 | N/A | N/A | 0.5 |
| Allentown | 0.5 | 0.5 | 1.5 | N/A | 0.7 |
| Pittsburgh | 0.5 | 0.5 | N/A | N/A | 0.6 |
| San Juan | 0.5 | 0.5 | N/A | N/A | 1 |
| Nashville | 0.5 | 0.5 | N/A | N/A | 0.5 |
| Austin | 0.5 | 0.25 | N/A | N/A | 0.5 |
| Dallas/Fort Worth | 0.5 | N/A | N/A | N/A | 0.5 |
| Houston | 0.5 | 0.25 | N/A | N/A | 0.5 |
| San Antonio | 0.5 | 0.25 | N/A | N/A | 0.5 |
| Richmond | 0.5 | 0.5 | N/A | N/A | 0.7 |
| Seattle/Tacoma | 0.5 | 0.5 | N/A | N/A | 0.5 |
| Spokane | 0.5 | 0.5 | N/A | N/A | 0.5 |

**Project Ask**

Because cargo transportation costs are a major contributor to the Amazon profit margin, the company has asked you to perform an analysis to minimize the total shipment costs to all centers while ensuring capacity needs are met.