Market Potential for Transport Airships in Service to Hong Kong[1]

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Abstract

The airplane carriage of international trade, based on complex supply chains and competition between hub-and-spoke transport operations, has developed steadily over the past 70 years into a mature industry. All this could be subject to disruption by aerospace technology advances that are leading to the development of transport airships. The emergence of transport airships has the potential to create fundamental changes in trans-oceanic freight transport markets, geographical coverage and world trade patterns. This paper explores the current state of the Hong Kong airfreight industry and examines how transport airships could influence the future of Hong Kong aviation services.

A new conceptual model, the value-density cargo pyramid, is developed to conduct comparative analysis among dedicated cargo airplanes, sea-air logistics, sea containers and transport airships, notably in the busy trade corridors between Hong Kong and Europe, and Hong Kong and North America. Based on reasonable assumptions, transport airships could capture up to half of the existing "dedicated cargo aircraft" capacity. The race is on to create this new transportation mode and the first-movers will have an advantage. This paper provides valuable insights on an immense opportunity that awaits Asian shippers and could take Hong Kong and all of Asia to a new higher level of development and economic prosperity.

Keywords: Transport airships, Innovation, Value-density cargo pyramid, Hong Kong, Asian shippers

1. Introduction

Advances in aerospace technology and the expansion of international trade make transport airships one of the most promising modes of freight transport that has yet to experience widespread use. Transport airships could fly over land or sea, which makes them a challenge to both airfreight and ocean container shipping. They could also overfly ports and deliver to inland distribution centres that obviate the need for trucking or rail moves to the hinterland. The transport airship is a disruptive technology that has the potential to modify freight transport markets, change geographical advantage and alter world trade patterns.

Technological changes that lower transportation costs can stimulate a rapid growth of trade because new opportunities are created. Shippers want to use more of the new transportation alternative because lower freight costs translate into higher profits for their production. At the same time, consumers who find that the prices of their purchases have decreased because of the lower cost transport want to increase consumption. Consequently, transportation innovations generate a double stimulus for trade that is the basis for an explosive demand of new transportation services. This paper explores the potential market for large transport airships that are soon to enter service.

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Naturally every mode of transport has its niche. Transport airships will not be carrying heavy low-value commodities, like coal, or extremely time sensitive air cargo, like human organ transplants. In this study, we develop a value-density cargo pyramid to conduct comparative analysis among dedicated cargo airplanes, sea-air logistics, sea containers and transport airships, notably in the busy trade corridors between Hong Kong and Europe, and Hong Kong and North America. Also, we examine how transport airships could influence the Hong Kong aviation service. This paper provides valuable insights on an immense opportunity that awaits Asian shippers and could take Hong Kong and all of Asia to a new higher level of development and economic prosperity. The discussion begins with some background on the development of the air transport industry.

1.1 Development of World Air Freight Markets

The transportation system links geographically separated partners and facilities in a firm's supply chain. Hence, transportation encourages the creation of time and place utility (Coyle, et al., 2013). During the last half of the 20th century, air transport emerged to facilitate trade between persons and to establish the foundation of global supply chains. Increased population mobility achieved through air transport allowed site selection in response to consumer functions and dispersion of urban population agglomerations with consequent development of outlying territories and suburban population.

Isard and Isard (1945) foresaw the development for air transportation in global trade. They proposed that the reduction in the cost of air transport would lead to increased geographic specification, generate mass production economies and reallocate market areas, source material and labor at the lowest cost around the world. Table 1 summarizes the costs of air transport from 1920 to the postwar period. The productivity that they observed has continued to grow with modern aircraft that can carry 20 times more cargo than the largest aircraft available following World War 2.

Table 1 Costs of Air Transport, 1920-1945

Aircraft	**Payload lbs**	**Direct Cost in Cents, Capacity Payload**		**Total Cost (direct[2] and indirect) in Cents, Capacity Payload**	
		Per Mile	Per Ton-Mile	Per Mile	Per Ton-Mile
DH (1920)	600	26.4	88.1	48.3	161.0
Boeing 40 (mid-twenties)	1,200	20.2	33.7	43.6	72.7
Ford (1925)	3,200	34.1	21.3	69.3	43.3
Lockheed Vega (1929)	1,350	15.1	22.4	38.1	56.5
Boeing 247 (1933)	2,800	21.1	15.1	51.9	37.2
Douglas DC-3 (1936)	5,000	26.7	10.7	68.6	27.4
Postwar Aircraft (2 to 4 years after war)					
Passenger	12,000	N/A	N/A	102	17
Cargo	16,000	N/A	N/A	76	9.5

Source: Isard and Isard (1945)

[2] Direct cost including fuel cost, pilot salaries, maintenance cost, depreciation, insurance and crash reserve

Kindleberger (1962) refers to impact of transportation innovation as a double stimulation to trade. The rapid growth of the railway industry in the 19th Century is an example of the disruptive nature of transportation innovations. As railway lines were extended into the undeveloped interiors of the continents, farming opportunities emerged that were previously uneconomic. This encouraged trade and settlement away from the coastal regions and made the demand for the railways self-perpetuating.

A similar experience has been occurring over the past three decades in ocean transport. Advances in container ships, double-stack trains and faster port handling equipment have lowered unit costs of ocean transport (Levison, 2006). The cause and effect of trade can easily be confused. However, the economic stimulus of innovations in container shipping cannot be ignored in the rapid growth of trade between Hong Kong, North America and Europe. It is arguable whether the modern economy of Asia would have been possible without the dramatic drop in ocean freight rates that accompanied the growth of containerized ocean shipping.

Comparable advances in technology make airships one of the most promising modes of freight transport. Cargo airships have yet to experience an explosive growth of demand, but the time is near. Prentice and Knotts (2014) describe the international competition to develop the first commercial transport airship that is underway on three continents.

Both technical and economic reasons lie behind the 80-year delay in the commercialization of large freight carrying airships. The principal reason is the huge military investments that were made in fixed-wing aircraft development during World War 2 and the Cold War period. The aviation industry experienced a turning point in the 1950s. The civilian airplane manufacturers (e.g., Boeing and Douglas) were able to adapt new jet engines and advances in avionics, structures and the design of former military aircrafts into civilian passenger airliners (Wells and Wensveen, 2004). During this period, fuel was cheap and no one cared about carbon emissions, travellers were focused on speed, trained pilots were plentiful and the military had solved the myriad of airplane safety problems experienced during the pre-war period. Hence, no compelling reasons existed to build rigid airships again that were considered too slow, unsafe and generally obsolete.

The introduction of the *Airline Deregulation Act* of 1978 stimulated competition to attain the objectives of innovation, efficiency, low prices and a wide variety of service options in the air transportation systems (Wells and Wensveen, 2004). It is worth noting that until the mid-1980s no market existed for dedicated cargo airplanes. Most air freight moved in the bellies of passenger airliners, and the high costs limited demand. Over the past 35 years air freight demand has changed. Older passenger jets are modified to carry freight, and the integrators, like FedEx, UPS, DHL and TNT have created new air cargo markets.

Air transport is considered a barometer of the global economy in the 21st century. Most air-shipped products have high value, high priority or extreme perishability (Coyle, et al., 2013). Air transport supports a wide variety of industries pertaining to food, flowers, clothes, entertainment, technology and leisure. Although air cargo volume represents only 0.5% of global trade by weight, by value air transport generates 34.6% (USD 6.4 trillion) of global trade. Air freight traffic is forecasted to outpace passenger traffic growth in most major world markets. The average annual traffic growth rate (2011-2030) of the Asia-Europe air cargo market could reach 6.2%, while the Asia-North America air cargo market is expected to grow by 6.1% yearly. Globally, the growth rate of airfreight demand now exceeds passenger demand growth (International Civil Aviation Organization, 2013).

A number of air supply chain challenges are emerging among the Asian, European and North American trading partners. The air transport industry relocation, directional imbalances, surface competition, airport curfews, terrorism, fuel prices, air and surface labor stoppages, lack of airport access, currency revaluations, trade restrictions and environmental regulations (International Civil Aviation Organization, 2013).

Transport airships are on the right side of history, when it comes to the environment. Grote et al, (2014) observe that the world's airlines burn 5 million barrels of oil daily, and that their contribution to anthropogenic CO2 emissions is increasing. "Even if all the mitigation-measures currently on the table were to be successfully implemented, it is doubtful that a reduction in civil aviation's overall absolute CO2 emissions could be achieved if forecast traffic-growth in the sector is realised." (Grote et al, 2014). The need to cut carbon emissions will ultimately cause the cost of Jet-A fuel to increase. This could be largely avoided by cargo airships. Not only do airships burn less fuel, they are so large that low pressure hydrogen fuel tanks are possible. The potential for a zero-carbon emissions transport airship is already within the reach of existing technology.

1.2 Transport Airship Technology

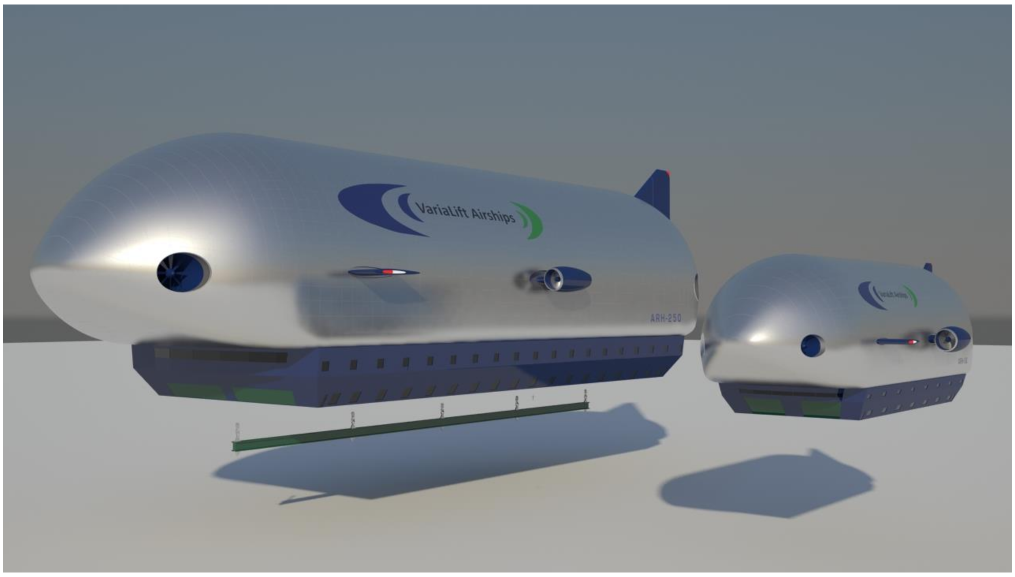
No obvious technological barriers remain to the development of transport airships. Fuel prices are no longer cheap, carbon emissions are a major concern and speed is not as important to freight movements, as it is for passengers. Although transport airships can fly over land and sea, they are more competitive with airplanes and ships than trucks and railways. The first generation of cargo airships is likely to have a payload capacity in the range of 20 and 50 metric tonnes (Prentice and Knotts, 2014). But vehicles with over 100 tonne payloads are on the drawing boards, and will be introduced once the technology becomes established. These larger transport airships will be able to operate over existing intercontinental shipping lanes.

The competition for the dominant design of a transport airship is producing many different variants. Two of the most important elements are buoyancy control and structure. The structural issues revolve around whether the airship will have a rigid, or semi-rigid, structure like a pre-World War 2 airship, or an inflatable non-rigid envelope with gondola and engines attached. Both designs work and each has merits as well as drawbacks (Prentice and Knotts, 2014). For example, the rigid structure is heavier such that the airship must be bigger to carry the same weight, but it is also more robust and less sensitive to temperature changes. The other advantage of the rigid airship is that the lifting gas is contained at atmospheric pressure, whereas the non-rigid (blimps) are pressurized. Consequently, the non-rigid airships leak more than the rigid designs.

Just like a ship that can float on the sea, airships float in an ocean of air. The natural buoyancy of an airship reduces the energy needed to transport freight. If cargo is removed however, some method must be used to control the ascendency of the vehicle. Buoyancy control can be obtained in many ways, from releasing gas, pressurizing gas, heating gas, adding/subtracting ballast or using the engines to force the airship up or down. The other possibility is to employ an aerodynamic airship structure that obtains enough lift from engine thrust to carry the cargo, but when unloaded remains somewhat heavier-than-air which avoids the need for ballast. All these methods are being explored.

Airships enjoy significant economies of size, which are similar to ocean going ships. The larger airships are not that much more expensive to build, but they are much more productive and less expensive to operate on a per metric tonne basis. Figure 1 presents an illustration of the Varialift airship that is being developed in the U.K. The picture contains two airships. The smaller version (on the right) is designed to lift 50 tonnes and the larger one (on the left) will carry 250 tonnes. These vehicles have very large cargo bays that actually form an important part of the vehicle's structure. They are also very large. The smaller ARH-50 is 150 meters long and 52 meters wide, while the larger ARH-250 is 300 meters long and 110 meters wide. The benefits of size are obvious. While the larger airship is twice the size, it will carry 5 times the cargo weight, and 10 times the cargo volume. However, the larger airship only burns about 2.5 times as much fuel. Naturally, the crew size is basically the same.

Figure 1 ARH-250 and ARH-50 Varialifter airships



Source: http://varialift.com/

Any airship greater than 50 tonnes lift could cross the Pacific Ocean, but in order to compete with fixed-wing aircraft they must be larger, and likely in the 250 tonne range. The reason is utilization. The large rigid airships of the 1930s cruised at approximately 135 kmhp, which was the most economical in terms of fuel consumption. Better engines may change that a bit, but in any case, it is only one-sixth the speed of a Boeing 747 airplane. So, in the time required for the airship to complete one circuit, the airplane might do five or six flights. The airplane may be four times more expensive to purchase and burn four times more fuel, but unless the airship carries more than twice the freight, the unit freight cost is not necessarily less. Of course this ignores the nature of the cargo which is the subject of the next section.

Direct comparisons between modes of transport are generally imperfect because each vehicle has its strengths and weaknesses. Airships are slower than airplanes, but their enormous size permits large cargo bays. Whereas an airplane can “cube-out”, before it “weighs-out”, an airship has the capacity to carry very low density cargo. It is also true that an airplane cannot load any cargo that does not fit through its door. Transport airships are being designed with large cargo doors that can accept difficult, awkward pieces of freight. Transport airships could reduce economic barriers for the carriage of low-density and low value-perishable cargoes.

A question that has vexed airship investors for years is the potential size of the market for transport airships. It is beyond the resources of the authors to estimate the demand for a non-existent vehicle, but we can set out the methodology by which such demand could be considered.

2. Conceptual Economic Model

Inter-continental freight markets cannot offer the variety of options available to shippers in continental markets. On the continents, shippers can choose from barge or coastal shipping, truck, rail and pipelines, as well as airplane transport. Virtually every combination of price and time is available to continental shippers. In the case of trans-oceanic transport however, only two extremes exist: slow and inexpensive marine transport, or very fast, expensive airplanes. Transport airships offer a mid-range of speed and cost for ocean transport that is not currently available.

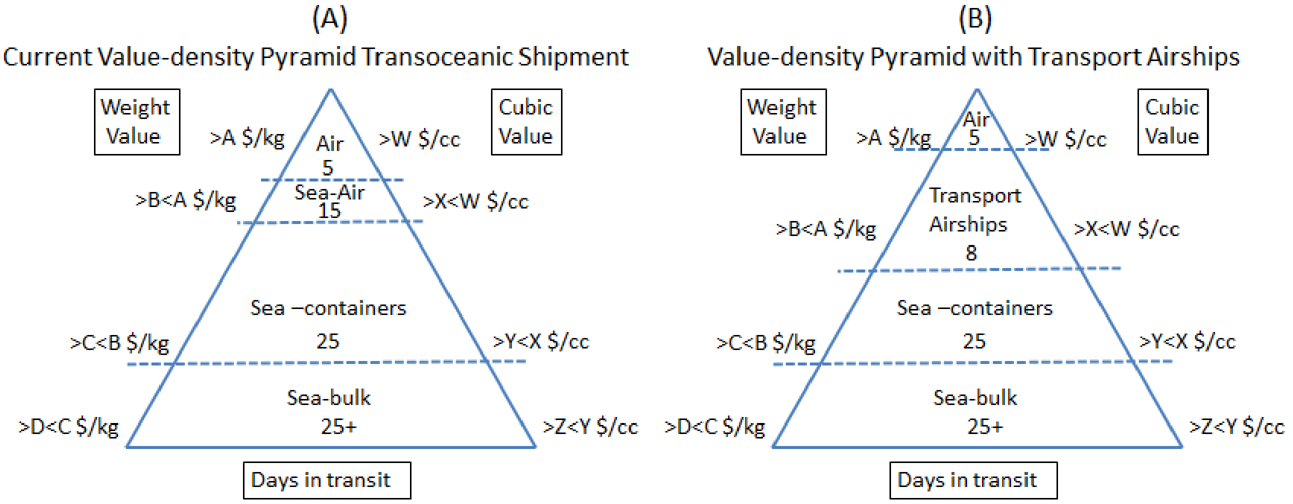
The latent demand for another option between the extremes of marine and air transport is illustrated by the sea-air shipping combination of ocean container and jet aircraft delivery. Goods are shipped from Hong Kong to European cities via Dubai in about 14 days. The first leg from Hong Kong to Dubai is by container ship, where the goods are transshipped to air cargo jets and flown to their European destination. This service is advertised to be at least 7 days faster than the sea route and 30 percent less expensive than a pure air freight option. Goods from Hong Kong can also be flown on to North America via Dubai in a total time of 15 days, or travel east across the Pacific and transship via Vancouver to North America in 18 days[3].

The full demand for transport airships is greater than just the sea-air component. Some products may be too low in value to justify the use of a sea-air combination, even at a 30 percent discount over direct air transport. Some merchandise may too perishable to withstand two weeks in transit. Finally, some cargoes may be too bulky to consider airplane transport. Transport airships could take the lower value goods moving by airfreight that are too perishable for sea-air, and the higher value goods moving by ocean containers that are too low in value or too bulky for air transport. In addition, there is a third market segment that does not currently move into intercontinental trade because the product is too perishable for ocean transport, but too low in value to consider sea-air or pure air transport alternatives.

Figure 2 presents a conceptual model of the Value-Density Cargo Shipping Pyramid that illustrates different transportation market segments, with and without transport airships. The pyramid in part (A) suggests the current pattern of shipping via air, sea-air, containers and bulk marine freight. The various cut-off points are estimates of transit time and cubic value volume that defines each market segment. The lower bound for dedicated cargo airplanes could be less than five days and above some minimum value, such as $15 per kilogram ($/kg). Also, the cubic capacity of airplanes may be such that the freight must be greater than some value per cubic centimeter ($/cc). The surcharge on cargo with a lower density would make it uneconomic.

Figure 2 Value-Density Cargo Shipping Pyramid

[3] Details on the sea-air service and a map of the routes can be found at http://www.emirates.com.hk/cargoflow.htm. Evereast Logistics also offers a sea-air service from Shenzhen to over 60 destinations in Latin America via LAX and MIA. They claim to be 60% cheaper than Airfreight and 60% faster than LCL http://www.evereastlogistics.com



The segment given to sea-air transport is smaller, and the largest segment would be for containerized cargoes. We do not make any attempt in this paper to quantify the boundaries of this pyramid, which is a larger study on to itself.

Figure 2 part (B) illustrates the transoceanic shipping market with transport airships. These vehicles would take over all the sea-air market. Conceptually, transport airships would eat into the lower part of the existing cargo airplane market. A lot of freight does not have to be delivered in hours, if can be delivered in days rather than weeks. Many freight shippers would be happy to wait three or four days longer if the price were halved. This is not an unreasonable estimate of the relative costs of airplanes and airships (depending on size). The air cargo moving in the belly holds of passenger airplanes would not likely be affected because this is a by-product that is priced to fill the available space.

Transport airships would also attract the higher value goods moving by ocean containers. Ocean shipping times from Asia to Europe or North America are at least 30 to 40 days from dispatch to receipt. This inventory-in-transit time is long, but products that do not have the value to density ratio required to be shipped economically by jet aircraft have only the sea-air choice. A significant market should exist for transport that could offer 5 to 10 day service at half the cost of airplanes.

A third component of the cargo that would move by transport airship is that which could be newly generated by the opportunity of a faster, low cost shipping method. No attempt is made to draw the value-density pyramids according to scale, but it is reasonable to expect that transport airships would induce larger volumes of some trade goods, and open entirely new markets for others. For example, the types and volumes of perishable food products that move between Southeast Asia, Europe and North America are very limited. Similarly, fully assembled upholstered furniture and large pieces of molded plastic are seldom moved long distances. These and other goods could become as widely traded intercontinentally, as they are continently traded.

As an indication of market size, we examine the air freight market of Hong Kong next in section 3. Hong Kong could become a representative air cargo market in the Asia Pacific regions in the following reasons (Hong Kong International Airport, 2014):

- Free port policy
- Strategic geographic location
- Excellent connectivity and accessibility
- Extensive IT application

- High safety and security
- Sufficient cargo capacity
- Efficient cargo operations
- Competitive costs

3. Hong Kong Air Cargo Market Case Study

Hong Kong is an air cargo market hub for Southeast Asia and a gateway to China[4]. The Hong Kong International Airport is located at the heart of the Asia Pacific region where the aircraft can move towards over half of the world's population within 5 flying hours. Apart from its geographical advantages, Hong Kong has well-established financial, institutional and legislative settings, as well as, skilled labor and an entrepreneurial culture. Hong Kong could be transformed from a regional relay hub into a world-class cargo center (Wang, 1998).

Before 1978, China adopted a closed door policy that adversely affected the major economic linkage between China and the Western world for almost 30 years. The centrally planned and self-sufficient economy induced in a small volume of trade via Hong Kong. The economic turning point emerged when Deng Xiaoping introduced the Open Door Policy in 1978 (Tang et al., 2014). The economic reform towards a 'socialist market economy with Chinese characteristics' resulted in an upward growth trend in air cargo (Wang, 1998; Tang et al., 2004). To implement such policies, China established special economic zones in Shenzhen, Zhuhai, Shantou, Xiamen and Hainan in 1980. Hong Kong's manufacturing sector moved northwards to China and then spread to the entire Pearl River Delta (PRD) region. In 1984, China further opened 14 coastal cities including Dalian, Qinhuangdao, Tainjin, Yantai, Qingdao, Lianyungang, Nantong, Shanghai, Ningbo, Wenzhou, Fuzhou, Guangzhou, Zhanjiang and Beihai. Hence, Hong Kong could absorb large amount of air cargoes from hinterland, notably the PRD provinces.

In the Asia Pacific trading area, Hong Kong serves as a regional relay aviation hub for domestic and re-export trading activities. In the volume of re-export trade, Asian countries have occupied for 67%, North America and Western Europe have contributed to 10% respectively (Wang, 1998). In order to cater demand for a consolidated air cargo service in Hong Kong's manufacturing economy, Hong Kong Air Cargo Terminals Limited (HACTL) commenced its terminal operations at Kai Tak International Airport in 1976 (HACTL, 2015).

HACTL established a wholly-owned subsidiary (Hacis) to provide on airport operations support and delivery in Hong Kong and intermodal connection to Southern China regions. The extension enlarged HACTL's capacity from 350,000 to 680,000 tonnes per year. Subsequently, HACTL built a second air cargo terminal. The annual air cargo throughput reached 1.7 million tonnes by 1997 (HACTL, 2015).

The air cargo market has demonstrated an explosive growth in the Asian regions in the 2000s. The airport relocation marked a turn point in Hong Kong's historical development. HACTL invested US$1 billion in SuperTerminal 1 in 1998. The cargo handling capacity has increased significantly. Asia Airfreight Terminal (AAT) owns 2 air cargo terminals with 1.5 million tonnes of handling capacity (AAT, 2015). In 2013, Cathay Pacific Services Limited (CPSL) operated the third independent air cargo terminals with a designed annual throughput of 2.6 million tonnes (CPSL, 2015).

[4] Beginning with the First Opium War (1839-1842), the excellent natural harbour made Hong Kong the gateway and anchorage for southern China.

Hong Kong is recognized as one of the world's leading international airports, handling about 4.13 million tonnes of cargo in 2013. By weight, air cargo represents around 1.3% of Hong Kong's total cargo throughput. However, it contributes to 37% of its total external trade value of HK$2,853 million in 2013. In the coming years, the cargo volumes would be increased by 2.7% per year (source: Hong Kong International Airport, 2014).

The HKSAR government has recognized that the air transport logistics industry is one of the four pillars in Hong Kong economy. Also, Hong Kong has joined PRD Airports Cooperation Forum with Guangzhou Baiyun International Airport, Macau International Airport, Shenzhen Baoan International Airport and Zhuhai Airport to increase air networks coverage within PRD area. Table 2 illustrates the air cargo throughput at HKIA since 1998. While the rapid growth faltered during the international banking crisis of 2008-2009, the lost traffic was quickly recovered. However, the rate of air freight growth has stagnated during the worldwide recession that followed.

Table 2: The air cargo throughput at HKIA

Year	Tonnage ('000 tons)
1998	1,629
1999	1,974
2000	2,241
2001	2,074
2002	2,479
2003	2,642
2004	3,090
2005	3,402
2006	3,579
2007	3,742
2008	3,627
2009	3,347
2010	4,128
2011	3,938
2012	4,025
2013	4,127

Source: Hong Kong International Airport, 2014

Hong Kong is the cargo hub for aviation logistics business among Southern China regions because of its excellent geographical location and comprehensive transportation system. Hence, the aviation logistics firms can shorten shipment time via Hong Kong (Lau, 2009). Compared with Manila, the required flight time is 10% shorter; Compared with Taiwan, the required flight time is 6% shorter; Compared with Singapore, the required flight time is 36 % shorter. The total fuel cost that could be saved is HKD 40 million per year (Schwieterman, 1993). Further details on the locational advantage on Hong Kong as an air transport hub are presented in Appendix A.

Transport airships could be seen as either a threat or an opportunity to the Hong Kong International Airport. On the one hand, transport airships could replace many cargo airplanes, or worse the airships could fly beyond Hong Kong and land closer to the ultimate markets. On the other hand, if this technology is coming anyway, then a wise manager would develop a strategy to maximize its use.

It would appear that Hong Kong has more to gain than potentially lose. First, as an established hub, Hong Kong has many feeder routes and businesses involved in logistics. Like all transport hubs, the long distance between major centres will be served by very large transport airships, while the feeder routes use smaller vehicles. The hubs are consolidation and sorting centres that make most efficient use of the larger vehicles and reduce the cost of shipping from smaller centres. There is no reason why Hong Kong could not evolve to be the largest transport airship hub in Southeast Asia.

Second, effective hubs are those that offer transshipment opportunities. With the availability of ocean container, land routes and air transport, Hong Kong is well-positioned to offer transshipment services via large airships. It might be that goods delivered across the ocean in a transport airship could be delivered in the belly freight of a flight to Nimbo, or other smaller Chinese cities.

Finally, Hong Kong has time to prepare itself for the opportunities that transport airships provide. Although airships are very large, they can operate from the shore as easily as from an airport. However, they need many services that airports offer, from security to re-fuelling. This is a new industry that is likely to create many more jobs than it eliminates. Those locations that take a proactive stance can be expected to benefit the most from the first-mover advantage that new technology offers.

4. Conclusions

Our paper identifies a new research agenda in the development of transportation and the aviation industry. Transport airships are soon to become a reality and trans-oceanic trade routes are extremely attractive for their use because of the limited options open to shippers: slow and cheap marine, or fast and very expensive aircraft. The new technology of transport airships will definitely influence the future of aviation industry (Wells and Wensveen, 2004). Transport airships could take at least half of the existing "dedicated cargo aircraft" capacity. Obviously, belly freight on passenger air liners would not be affected because it is a byproduct of the passenger service. An estimate of the space available in cargo airplanes, multiplied by the daily ton-miles for each aircraft would provide a target for the future transport airship demand.

Density and value have an impact on modal choice. Whatever the size of the sea-air market, just below its current density-value cut off is a much larger airship transport market of products that currently move in ocean containers. Higher value-low density ocean container freight could migrate to transport airships. In addition, some products go by sea because of their bulkiness and shape. The exact volume of traffic that would migrate from ocean containers to transport airships is open to conjecture. One factor that might influence this volume is port congestion and labour disputes. Transport airships do not need to stop at the coast, or at established airports for that matter. They could continue inland to new locations that are developed expressly to transfer goods from transport airships to trucks for final delivery.

Another potential market for transport airships is the demand created by the stimulation of trade. For example, buyers who can only purchase products for special occasions or seasonally, e.g. strawberries, want to buy more because the improvement of transportation has lowered its price and they can be sourced from more locations year-round. Similarly, the sellers benefit from the lower cost of transport because they get paid more for what they produce. Consequently, the double stimulus of supply and demand, yield a large market increase for the new mode of transport.

The double stimulus of trade is not a zero-sum game in which the gains to the airship are losses from airplanes or ocean containers. Although the magnitude is unpredictable, entirely new demands can be anticipated that do not even exist today. A case might be made for bulky, labour-intensive manufactured products that are now sold only on a local basis, such as upholstered sofas.

Both technical and economic reasons lie behind the 75-year old delay in the commercialization of large freight carrying airships, but in the 21st century no obvious technological barriers remain. The race is on to create this new transportation mode and the first-movers will have an advantage. Ultimately, it is our prognostication that the transport airship industry will be as large as the current commercial airline industry.

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Appendix A

From the geographical perspective, Hong Kong is located at an optimal location in Asia Pacific region for air transport. Air logistics firms can deliver cargo to over half of the world's population within 5 flying hours. The shorter flight hours allow the air logistics firms to achieve the greatest cost advantage by using HKIA. The airport is also located with 12 to 15 hours flight time to all the major financial and commercial centres of the world. To explain this in detail, the flight hours between Asian hubs and intercontinental hubs and the flight hours between regional hubs are presented in Table A1 and Table A2, respectively.

According to the Hong Kong International Airport (2014), the HKIA is connected to over 180 locations in over 50 countries. Thus, HKIA can attract more than 100 airlines (including 19 freighters) operated in HKIA. Aircraft land on and off the airport around 1,000 times per day. In order to achieve sustainable competitive advantage, the Airport Authority Hong Kong invested HKD4.5 billions to enlarge its apron for new large aircraft A380 and the Low Cost Carrier. 10 additional Cargo Stands have been built in 2007. In addition, the third runway is planned for launch in 2023. HKIA anticipates that the cargo volumes will average 6% growth per year in the coming 20 years (Hong Kong International Airport, 2007).

Table A1: Flight hours between Asian hubs and intercontinental hubs

	Hong Kong	Shanghai	Guang-zhou	Singapore	Seoul	Taipei	Bangkok	Tokyo	Osaka	Dubai
Paris	13h40m	11h55m	12h50m	13h10m	11h45m	X	12h	12h30m	12h25m	7h50m
Frankfurt	12h50m	11h10m	12h15m	12h40m	11h20m	13h40m	11h15m	11h40m	12h10m	6h45m
Los Angeles	13h15m	14h45m	12h50m	18h05m	11h	11h35m	15h30m	9h55m	10h25m	X
New York	15h45m	17h30m	X	23h	13h40m	17h50m	17h10m	12h30m	X	10h10m
Chicago	14h32m	13h25m	X	20h30m	12h50m	X	X	12h20m	12h2m	X
Amsterdam	12h40m	10h45m	14h35m	13h25m	X	X	11h45m	12h	9h55m	7h10m
London	12h45m	12h00m	X	13h35m	11h35m	11h40m	12h05m	12h35m	12h30m	7h35m

Sources: Cathay Pacific Airways Limited (2006)

Table A2: Flight hours between regional hubs

	Hong Kong	Shanghai	Guang-zhou	Singapore	Seoul	Taipei	Bangkok	Tokyo	Osaka	Dubai
Hong Kong	X	2h20m	45m	3h45m	3h20m	1h40m	2h40m	4h05m	3h45m	7h50m
Shanghai	2h20m	X	2h	5h15m	1h45m	X	5h30m	2h50m	3h20m	X
Guangzhou	45m	2h	X	3h55m	3h10m	X	3h	4h20m	3h20m	7h55m
Singapore	3h45m	5h15m	3h55m	X	7h20m	6h30m	2h25m	8h10m	7h30m	9h15m
Seoul	3h20m	1h45m	3h10m	7h20m	X	2h30m	6h20m	7h55m	1h40m	12h15m
Taipei	1h40m	X	X	6h30m	2h30m	X	4h10m	3h15m	7h03m	9h50m
Bangkok	2h40m	4h20m	3h	2h25m	6h20m	4h10m	X	6h10m	6h30m	6h50m
Tokyo	4h05m	2h50m	4h20m	8h10m	7h55m	3h15m	6h10m	X	1hr05m	12h45m
Osaka	3h45m	2h05m	3h20m	7h30m	1h40m	2h35m	6h30m	1h05m	X	12h
Dubai	7h50m	X	7h55m	9h15m	12h15m	9h50m	6h50m	12h45m	12h	x
Total	28h10m	30h5m	30h5m	54h05m	46h15m	33h35m	43h35m	50h35m	46h13m	90h

Sources: Cathay Pacific Airways Limited (2006)

The tangible cost between Hong Kong International Airport, Guangzhou Baiyun International Airport and Shenzhen Baoan International Airport, according to GHK (Hong Kong) Ltd (2006), is compared in Table A3. The air logistics firms could obtain the greatest cost advantage if they consider in selecting HKIA. Hong Kong air cargo business benefited from the first mover advantage over their neighbouring competitors.

Table A3: Comparison of Tangible Cost between Hong Kong International Airport, Guangzhou Baiyun International Airport and Shenzhen Baoan International Airport

Airport / Destination	**Hong Kong International Airport**	**Guangzhou Baiyun International Airport**	**Shenzhen Baoan International Airport**
Los Angeles	HK$19,750	HK$24,900	HK$27,000
Frankfurt	HK$27,150	HK$28,400	HK$29,300
Tokyo	HK$18,800	HK$18,900	HK$19,300

Sources: GHK (Hong Kong) Ltd (2006)