

Planning Method of Airport Economic Zone Based on 'Time-Critical' Orientation

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Abstract:

The airport and its surrounding areas have promoted economic growth and urban development in the region. This paper is based on the Aerotropolis theory by John D. Kasarda, the father of the global aviation economy. This paper will summarise the experiences of existing Aerotropolis across the globe in terms of policy framework, economic characteristics, industrial or transport development layout. In this paper, by generalizing and summarizing practical experience, it is deemed that the planning method of airport economic zone includes four aspects: (1) introduce airport industry and function oriented by 'time-critical'; (2) the site selection is mainly in its 'fast accessibility' to the airport runway; (3) transportation should be beneficial to improving the 'connectivity' between airport economic zone and airport runway; (4) establish the corresponding 'collaborative mechanism' to realize the collaborative and efficient operation of airport, airport economic zone and city.

Keywords

Time-Critical, Airport Economic Zone, Speed economy, Site Selection, Transportation, Coordinated Development

1. Introduction

Economic globalization has increased the closeness of personnel and material exchanges between different regions, with airports and air transportation as important carriers. Based on the development of aviation finance, aviation logistics, biomedicine, cutting-edge manufacturing, tourism and other aviation-related industries, the airport and its surrounding areas have promoted economic growth and urban development in the region.

Take Amsterdam as an example, in 1986, the 'van der Zwan' committee and the transport lobby broadened the mainport concept. The mainport concept created by Schiphol Airport was recognized by the committee and lobby. In response to the economic recession, The national government adapted the mainport concept in 1988. In the Fourth Report on Spatial Planning the mainport concept appeared. One of the cornerstones of the Fourth Report is Nederland Distributieland (the Netherlands, distribution land). Trade, transportation and distribution are the areas of expertise in the Netherlands. The Fourth Report pointed out that strategic investments in the expansion of the two mainports, Schiphol Airport and the Port of Rotterdam, are necessary. The growth potential of Schiphol Airport has received widespread attention for the first time, and people generally agree that the development of the airport promotes economic development (Cammen & Klerk, 2003). Taking the mainport concept as an example, the Dutch government emphasizes that the mainport is an important economic engine in the Netherlands. Schiphol Group stated that the mainport is a hub for global transportation flows between the world's major economic regions (Jong, 2006). Schiphol has become the main economic growth engine in the national

development strategy. The Amsterdam metropolitan area is affected by the development and construction of the airport, and the entire city area has participated in the development of the airport economy. This allowed the Netherlands to finally gain new momentum and direction after a long economic recession in the second half of the last century. Airports are extremely important for urban development.

As a significant policy area macroeconomic control and an important carrier of high quality development of local economy, airport economic zone's planning method is different from that of ordinary urban areas, especially in the era of developing 'speed economy' based on time efficiency, air transportation is a major route to improve transportation efficiency and benefits, therefore, the airport economic zone with air transportation as its core power is supposed to take the improvement of 'time-critical value' as its main orientation. This paper will summarise the experiences of existing cases across the globe in terms of policy framework, economic characteristics, industrial or transport development layout. In this paper, the case-study method is adopted to generalize and summarize planning method of airport economic zone based on 'time-critical' orientation.

2. Research Background

2.1. Airport Economic

In 1991, Kasarda proposed the fifth-wave theory, supporting the assertion that air transport could meet the requirement for long-distance, wide-space, high time efficiency in international trade (Kasarda, Rondinelli & Ward, 1996). Economies of speed provided by air transport is a form of economic power that is completely different from economies of scale.

Aerotropolis is a metropolitan sub region whose infrastructure, land use, and economy are centred on an international airport. It consists of two components – the airport's aeronautical, logistics, and commercial facilities that make up a multimodal, multifunctional 'airport city' at its core and outlying corridors and clusters of aviation-oriented businesses and industries that benefit from proximity to each other, the airport, and other key transport infrastructure. The primary value proposition of aerotropolis is that it offers businesses located near or with good transport access to the airport speedy connectivity to their distant suppliers, customers, and enterprise partners.

The following difficulties may exist in the planning of the airport economic zone in China: (1) The internal plans of the airport and the urban plans involve different profit-making entities, which make it challenging to coordinate with each other; (2) To achieve quick transportation access to the airport, the airport corporation, government departments and relevant passenger and cargo enterprises need to agree on the project's location, the construction of the road network and the control of the fencing network, etc. However, it is not easy to coordinate the implementation of the project at the moment. (3) The import of industry around airport should follow the principle of 'time-critical value' to avoid excessive pursuit of economies of scale.

Kasarda pointed out that the main points for the development of airport economy are: improving the efficiency of airport ground transportation and the coordination of multimodal transportation and aviation plans; at the same time, connecting more global suppliers and customers through route improvement and corporate partners; build a complete set of logistics and commercial facilities to support airlines, air travellers, aviation-related companies and their employees. Attract high-end, just-in-time (JIT) manufacturing and distribution facilities, tourists, and modern business services, especially the importance of introducing TIME-CRITICAL oriented industries.

2.2. Time-Critical Value

Just-in-time manufacturing (JIT) is a system designed to reduce product production time while shortening supplier response time. TIME-CRITICAL-oriented industries are considered to be an important basis for judging whether air cargo or passenger flow services are fast, efficient, and high-value. The concept of instant value was applied in the research of logistics and system network in the early days, used to express quick dispatch for the purpose of shortening time (Dai & He, 1995), an expression of the time sensitivity of transportation. TIME-CRITICAL-oriented industries refer to those industrial functions that have a high demand for fast transfer.

In this paper, by generalizing and summarizing cases, it is deemed that the planning method of airport economic zone includes four aspects: (1) introduce airport industry and function oriented by 'time-critical'; (2) the site selection is mainly in its 'fast accessibility' to the airport runway; (3) transportation should be beneficial to improving the 'connectivity' between airport economic zone and airport runway; (4) establish the corresponding 'collaborative mechanism' to realize the collaborative and efficient operation of airport, airport economic zone and city.

3. Introduce Airport Industry and function oriented by 'time-critical value'

3.1. Features of industrial functions

Time-critical value focuses on: the value generated by delivering products or services to customers in the global market in a very short period of time. In an aerotropolis, industries relying on the development of airport transport are oriented by the 'time-critical value'. This type of industry has five characteristics: (1) It is the high value-added industrial link and functional link in the industry chain, for example in the assembling link of smart phones, the assembled smart phones must be instantly delivered to global clients via air transport; (2) it is highly time sensitive, for example the flower auction market in the Netherlands is ten minutes' drive to the south of the airport, and freshly cut flowers can be immediately distributed in the world via an expressway; (3) it needs to minimize the time and cost and maximize the safety in transport, for example the biomedical industry in Minneapolis requires both policy and facility guarantees, including full-journey cold chain transport, customs clearance in air and seamlessly connecting to cold storage on the ground; (4) it needs to maximize the connections between the airport and the supply chain along extensive air routes, for example the Memphis Airport is connected to American cities and even most countries and regions in the world depending on the extensive national and international air routes established by the FedEx; and (5) it needs a short connection between the production base and the airport runway, or the industrial value will be degraded by a long connection. Successful airport comprehensive bonded zones, such as the comprehensive bonded zone at the north of Xinzheng International Airport, are all directly connected to airport runways, with instant production, logistics and e-commerce services are deployed inside.

3.2. List of industrial functions

The orientation of 'time-critical value' for the industry around an airport relates to: the speed to access global markets, the market agility of the product, and the connectivity to the global markets or supply chains. These were proved by Foxconn's work in the Comprehensive Economic Experimental Area at Zhengzhou Airport, as when an instant order for Apple mobile phones was generated, related parts were instantly delivered from global suppliers to the comprehensive bonded zone in this experimental area via air transport, then assembled and packed by skilled workers immediately, and finally the finished products are bonded and distributed to global markets. Because of such efficient production, the output of mobile phone from Zhengzhou shared more than 1/6 of the global output in 2018; and in the first quarter of 2020 when the COVID-19 was at its worst, Foxconn's factory in Zhengzhou, oriented by the

concept of time-critical value, still achieved a total import and export volume of RMB 60 billion, sharply increased by 14.8% year on year (Yang ling, 2020).

Among goods transported by air, flowers, fresh food, electronic products, medicine and medical equipment, express e-commerce packets, and high-tech product parts, etc. are highly dependent on 'time', and related production, processing, logistics, management and R&D are mostly added with high time-critical value. Moreover, traveling businessmen and industrial servicemen are those with high demand for air passenger transport, and more than 50% of international tourists and more than 90% of commercial service exports are transported by air. For example, a KPMG's office is housed in 'the Squire', a complex outside the Frankfurt Airport terminal, a large number of high-tech headquarters and media companies are located in the Crystal City outside Washington Reagan National Airport, and these white-collar workers demand high for fast connection to global customers, which is an epitome for the time-critical value of passenger transportation.

Concluded from global cases, a list of industries with 'time-critical value' is obtained:(1) Logistics service providers: aviation logistics, value-added logistics, cold chain and other special logistics;(2) Manufacturers: manufacturers of semiconductors, computer chips, computer and electronic parts, suppliers of important aircraft parts, manufacturers of scientific or medical industrial supplies, optical and small high-value devices, manufacturers of fast-moving clothing and fashion clothing accessories, manufacturers of medical equipment, manufacturers of fresh and perishable products, gem, jewelry and watches, and manufacturers of special auto parts, etc.:(3) Aviation-related service providers: airlines, aircraft maintenance, training, airline services, and aviation catering, etc.;pharmaceutical biotechnology contract manufacturing companies and clinical research organizations (CRO);(4) Universities engaged in technological innovation and scientific research; (5) Related service industries: law, audit, accounting, consulting, media, management, finance, corporate headquarters or general office areas, conferences and exhibitions, hotels, leisure and entertainment, and sports venues.

4. The site selection is mainly in its 'fast accessibility' to the airport runway

4.1. Location of the airport economic zone

The core goal of the location of the airport economic zone is to maximize the 'accessibility' to the airport, and to increase the 'time-critical value' of land use from the site selection level. Airport economic zones are usually located based on two principles: (1) In China, an airport economic zone is generally delimited by policies from top to bottom, it's usually large and arranged around the airport, and occupies all construction land around the airport as much as possible; and (2) some internationally mature airport economic zones gradually developed from bottom to top, such as the airport economic zone at the Amsterdam Schiphol Airport in Netherlands and the airport economic zone at the Paris Charles de Gaulle Airport in France, generally focus on the land use efficiency and the airport accessibility.

In China, Beijing Capital Airport Economic Demonstration Zone (115.7km²) approved in 2019, Guangzhou Airport Economic Demonstration Zone (135.5km²) approved in 2016 and Hangzhou Airport Economic Zone (142.7km²) approved in 2017 have similar characteristics that the land areas are large and they are planned closely around airports.

Mature airport economic zones gradually formed are significantly different from the above zones in locating. For example, the airport economic zone around the Amsterdam Schiphol Airport was located and built with the development of the Amsterdam metropolitan, governments at all levels, airport groups and developers were organized into a unified foreign investment promotion and enterprise location recommendation agency (the AAA agency, Amsterdam Airport Area) to assist companies in locating (Amsterdam Airport Area, 2021). The adjacent areas of the airport mainly distributed some logistics parks and business parks, covering the headquarters of air transport, electronic information and high-tech

companies, as well as insurance, financial consulting, hotels, tourism and leisure industries, etc.; and the original management mechanism of the airport economic zone directs the efficient development and use of land. The Amsterdam airport economic zone is arranged along the traffic lines and combines expressways, high-speed railways, national railways and intercity railways, as a result, the accessibility between the airport and the zone is improved and the land value of the airport economic zone is heightened, which can be proven by the rents for Zuidas and BP Riekerpolder parks, and the rents for parks and offices distributed around the airport zone are also higher than those in the urban centre.

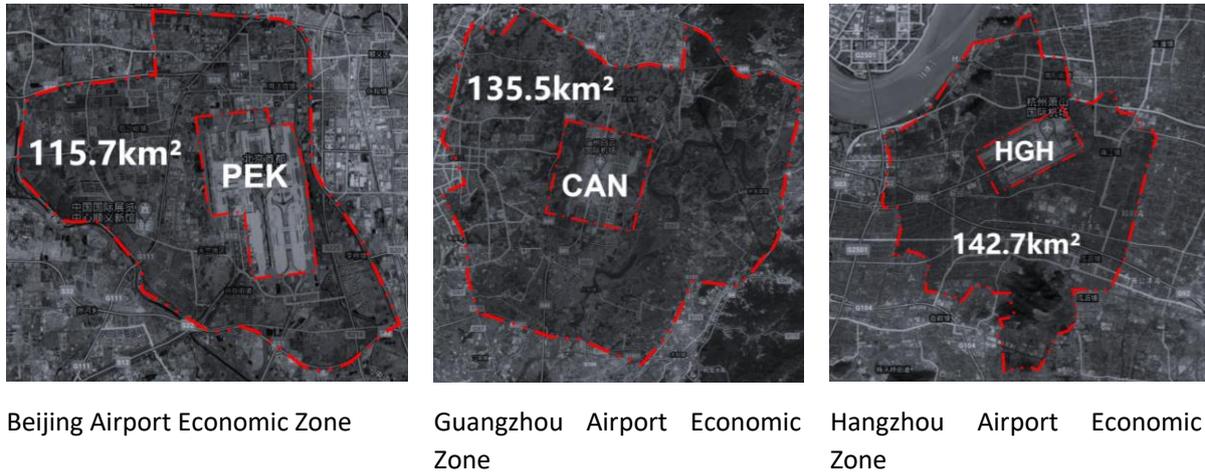


Figure 1. Airport economic zones' location of China. Source: Author

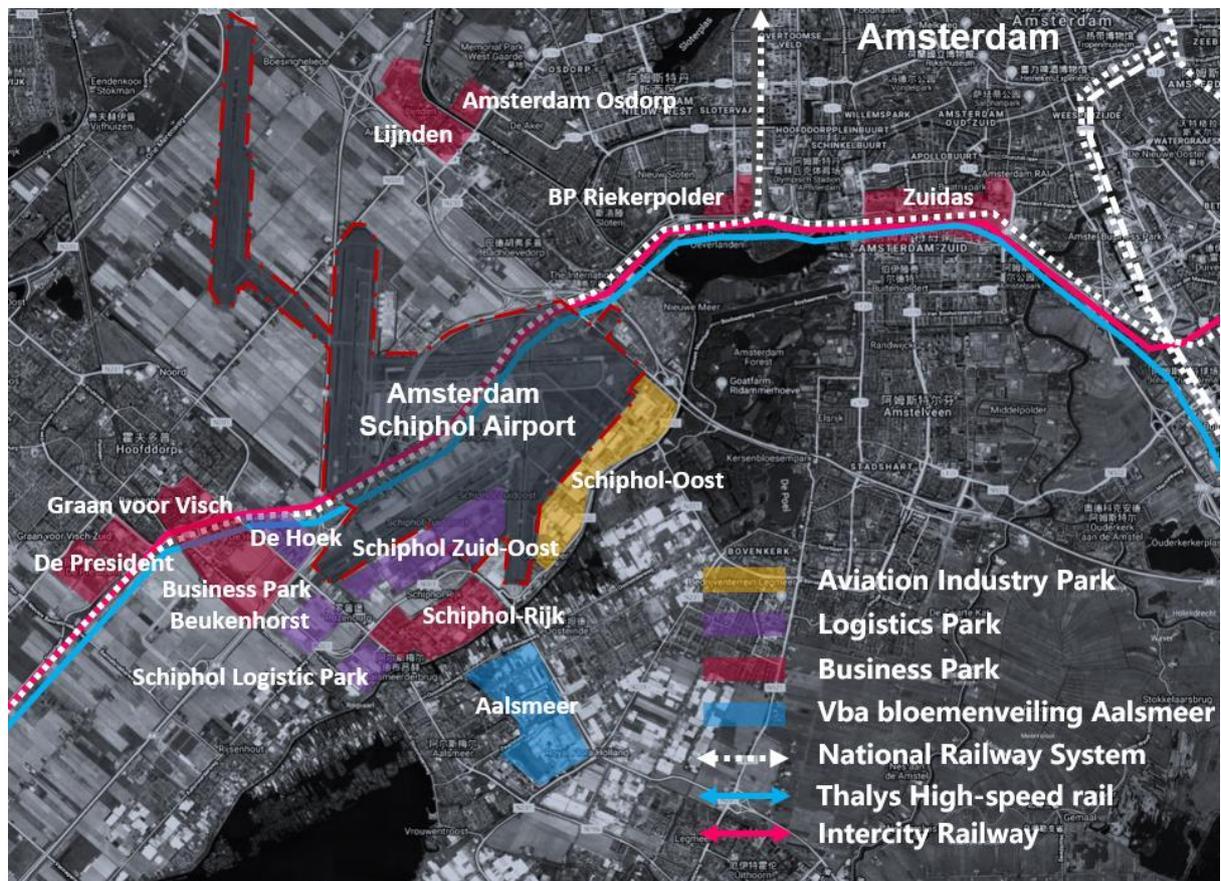


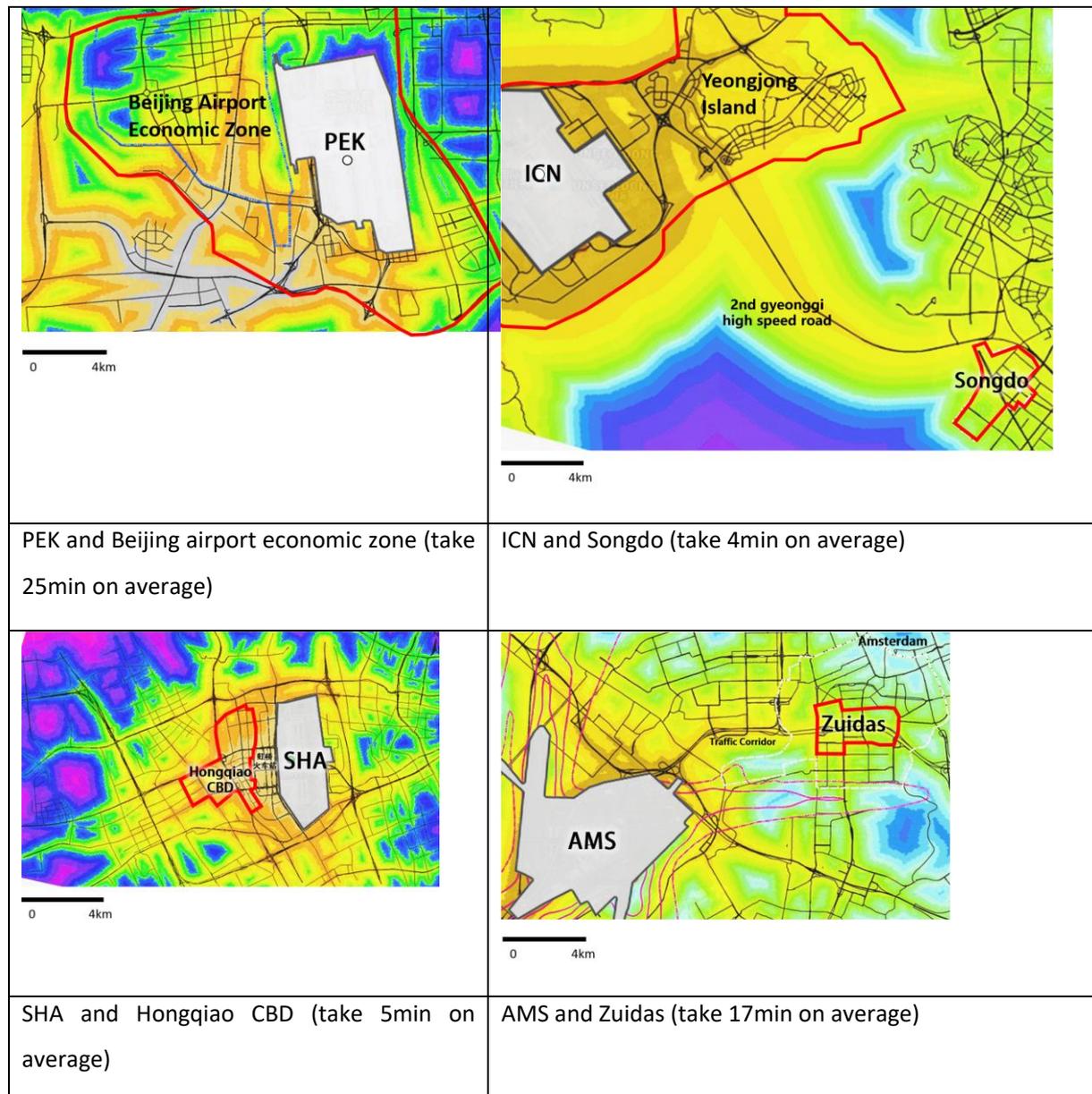
Figure 2. Amsterdam Schiphol Airport area's business and industry parks' location. Source: Author

Urban Area	Rent (€ /m ² /year)
Amsterdam downtown area	500-600
Zuidas, Riekerpolder and so on	600-700
Airport area	550-650

Table 1. Office rentals comparison of different areas. Source: Data compilation on Dutch real estate website

4.2. With the impact of the airport fence, the length of time to enter the airport from airport economic zone is important

As a construction and development area independently operated by the airport group, the airport is usually strictly fenced and with fixed entrances and exits. Therefore, it is not that the closer to the airport fence, the easier to connect to the airport runway or terminal building; some airport economic zones are located near the fence but have to detour to the airport entrance. This is a significant difference which can be proven by accessibility analysis and comparison:



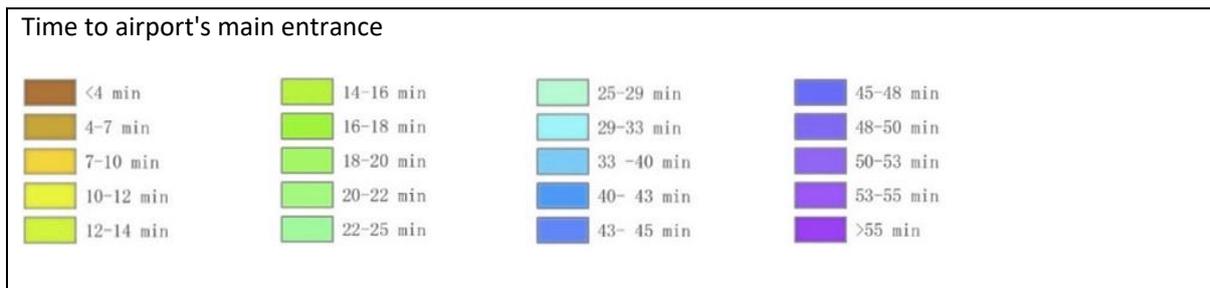


Table 2. Accessibility between airport and Airport economic zone. Source: OpenStreetMap

It's found that New Songdo City is 25km away from the Incheon Airport, and the Zuidas area is 15km away from the Amsterdam Schiphol Airport, both can be directly connected to the airport entrance or terminal building through expressways or railways in 14mins and 17mins respectively, much better than the Capital Airport economic zone. The Capital Airport economic zone closely surrounds the airport, and the farthest border is within ten kilometers from the airport border, but it averagely takes 25mins to enter the airport from the entire airport economic zone.

The Amsterdam airport economic zone was planned upon the importance attached to airport accessibility and the direct connectivity to the airport entrance, it was located mainly in consideration of the highway and expressway network entrances and exits, railway and rail transit stations, surrounding areas, and the airport entrance and exit, and the general layout is decentralized (see Figure 2 for details). For example, the Zuidas area was built around the railway station, and the financial offices and European corporate headquarters and bases settled there have greatly extended the airport peripheral service functions and attracted the settlement of 'time-critical value' oriented industries.

5. Transportation should be beneficial to improving the 'connectivity' between airport economic zone and airport runway

An airport economic zone must be located in consideration of the connectivity to the passenger and cargo entrances of the airport. Location is as important as traffic connectivity. In areas where the ground traffic and the airport are not well connected, it is recommended to build inter-city railways, rail transit, and the highway and expressway networks to form comprehensive traffic routes, improve the connectivity between the airport economic zone and the airport entrance, so as to achieve the fast centralization and decentralization of passengers and goods in the zone.

5.1. Freight distribution: truck transport completes 'warehouse to client gates', multimodal containers complete 'warehouse to warehouse' via rail lines.

As an important means of airport cargo centralization and decentralization, truck transport can be easily achieved by establishing a good land transport infrastructure and an internal cargo transport management system for the airport. In recent years, it has come up with an idea of establishing 'air-rail transport' for high-speed railway cargo transport and airport cargo transport to realize multimodal transport via 'railways, highways and airports'. International transport expert Ram Menen has mentioned two practical cases in which he participated in relation to the author's view on 'railway — highway — airline' cargo transport: the first is that the KLM Royal Dutch Airlines has made an experiment to establish a cargo transport connectivity between the Amsterdam Schiphol Airport and the railway station in the middle of 1990s, but it was finally discontinued due to frequent cargo transfer and too much time wasted. The other one is the 'station-to-station' long-distance trunk line transport by multimodal containers on railway plus the 'station-to-gate' short-distance connection by trucks, which can effectively accelerate the transport as containers are not separated per se during the entire course. Dubai has made a success in paving special cargo railways between two international airports, and because of such high efficiency

achieved by multimodal containers, the cargo owners could hardly feel any time loss due to transfer between the two airports.

Based on the experience of Netherlands and Dubai, it's the major trend to develop multimodal cargo transport for future airports and also the major way to improve the cargo transfer between the airport economic zone and the airport by building dedicated cargo transport highways and railways between the airport economic zone and the airport, connecting the airport cargo zone to the external logistics bases, completing the 'station-to-gate' by trucks, and completing the 'station-to-station' by multimodal containers.

5.2. Passenger distribution: transit through airports, high speed railways, railways and high-speed roads

As for passenger transport, an integrated transportation system may be created by connecting the airport to highway, expressways, high-speed railway, and rail transit. For example, the Incheon Free Economic Zone has developed into an airport economic zone composed of several core areas which are connected to the airport economic zone by different modes of transportation. Before 2003, the passenger transport via the Incheon Airport had reached 2 million, and the airport was supported by favorable transport infrastructure and communication conditions. From 2003, Incheon began to develop its airport-related economy and promote the development of the Northeast Asia logistics center based on the 'multimodal transport'. Since 2015, the development of sub-areas has made initial achievement. To be specific, the Yeongjong area is closely arranged around the airport and connected to the airport terminal building via ground transport and multi-mode rail transit, with a lot of aviation industrial centers and airport entertainment and leisure functions distributed, of which the most distinguished is Songdo International and New Songdo City, for which a large sea-crossing bridge was built to connect the airport directly, and it only takes 17 minutes to enter the airport.

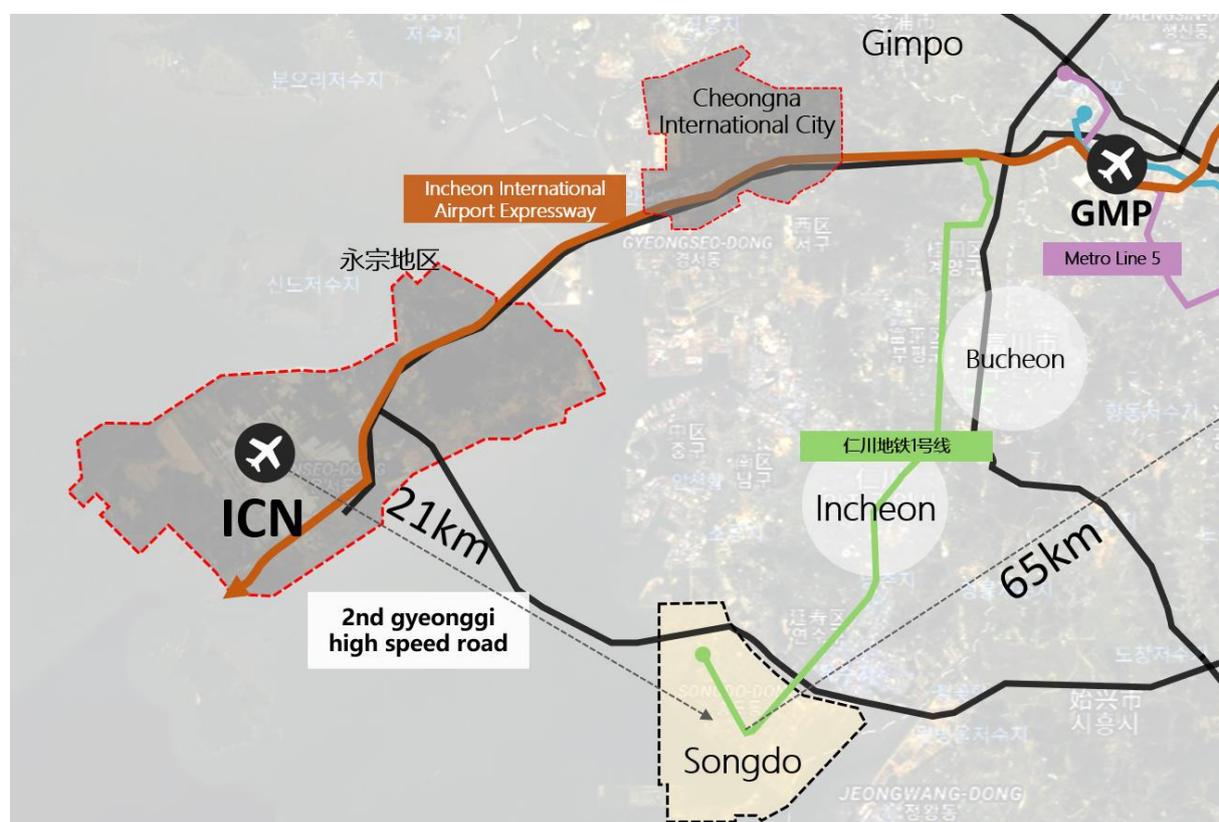


Figure 3. IFEZ and cities around it. Source: Website of IFEZ

The transfer between the airport and high-speed railways, rail transit, highways, and expressways has accelerated the construction and development at the highway and expressway entrances, exits, stops and rail transit stations. In the Amsterdam airport economic zone, the investment promotion and enterprise location recommendation agency AAA (Amsterdam Airport Area), in order to control the valuable land around Lelystad Airport — the second airport in Amsterdam (it will gradually replace the international passenger transport function of Amsterdam Schiphol Airport), has targeted the land for logistics and commerce at the entrances and exits of the nearby Express Highway A6 as important blocks in the airport economic zone. The airport economic zone can be developed by effectively improving its 'time-critical value' through connecting fast transport into the airport transport infrastructure.

6. Establish the corresponding 'collaborative mechanism' to realize the collaborative and efficient operation of airport, airport economic zone and city

The establishment of an efficient coordination mechanism inside and outside the airport should be included as an important part in planning an airport economic zone, and an important strategy for the development and management of the airport economic zone in the future.

The airport and the city are two separate subjects, and the key to the development of the airport economic zone is to optimize the connection to the airport. The aforementioned "industry introduction", "spatial location", and "transport connection to the airport" are essentially depending on the coordination between the airport economic zone and the airport. As two main bodies, it's more or less hard for the airport group and the local government to coordinate between them, so there will be some contradictions in construction between the airport economic zone and the airport.

For example, the Frankfurt Airport, there is a 30-hectare airport industrial park outside, named "Gateway Gardens" (Gateway Gardens, 2021, in which there is an aviation food base to supply food for the airport, the food must be quickly sent into the airport and onto the planes after being made, and thus a special cargo passage is set between this industrial park and the airport fence and connected to a road inside the airport to greatly improve the efficiency to serve the airport. This is based on the efficient and coordinated operation of the airport and the external airport economic zone.

In order to realize the internal and external collaboration between the airport and the airport-related economy, there are two common strategies: one is to promote collaborative development by a company jointly operated by the management entities inside and outside the airport, for example, Hongqiao hub area is operated by a company with shares held by several entities; and the other is to establish a non-profit platform organization to assist the government in making decisions, attract investment and help enterprises select locations and settle in, and provide economically reasonable, market-worthy, high operation efficiency policies and suggestions in consideration of all interested entities.

6.1. Multi-entity companies operate in collaboration for the benefit

In Hongqiao hub area (the airport, railway station and surrounding areas), the integrated investment and construction management entity is Shanghai Shenhong Investment and Development Co., Ltd. (Shenhong Company for short). The Company was mainly controlled by Shanghai Airport Group, and jointly controlled by Shanghai Jiushi Group and Shanghai Land Reserve Center. The three shareholders represent governmental funds, governmental land, and the airport, and they combine the airport group and the city government to coordinate the work in the airport, the railway station and the peripheral business zones (Liu Wujun, 2014).

As the airport economic zone of Hongqiao Airport and located in the periphery of the airport, Hongqiao Business District is also planned, invested in and constructed by Shenhong Company, and

comprehensively managed by Hongqiao Business District Management Committee as the local office. Since the Company's shareholders represent the airport, the government, and the land supplier respectively, it has integrated the development of the airport and the external airport economic zone, and resolved many problems in plan implementation. And meanwhile, in order to develop the construction more efficiently, a more extensive coordination mechanism was established through Shenhong Company, and civil aviation, railway, airport companies, maglev companies, subway companies, long-distance bus companies, taxi companies, and related municipal units were invited to coordinate the construction affairs inside and outside the airport. (Shanghai Shenhong Investment Development Co., Ltd., 2021)

6.2. Non-profit platform to guide construction

In the Amsterdam airport economic zone, two core development companies — Schiphol Real Estate Corporation and Schiphol Regional Development Corporation were established, in which the airport group (Schiphol Group) invested and governments at all levels participated and directed. During the development state of the airport-related economy, as mentioned above, a public-private cooperation platform (AAA) was established by the develop company, the government, and the airport to support the government work and coordinate all affairs in the zone. It is distinct that the development company represents the interests of local and provincial-level governments and airport group, and the non-profit organization AAA platform fairly represents the common interests of the above entities.

AAA, a government-led platform organization makes no profit for itself but is fair to coordinate multi-entity collaborative development so that all participating entities can make profits together. In the Amsterdam airport economic zone, when a company that intends to settle in fixes a location at the airport as recommended by AAA, AAA will introduce the company to the land owner and developer, and AAA is also responsible for the operation, advertisement and management of the development area. To maximize the collaboration for more interests, AAA platform is engaged with many partners, including real estate developers, banks, logistics companies, green parks, and investment companies, etc.

7. Summary

The airport economic zone has been developed in China for more than 20 years and 17 national airport economic zones have been approved since 2013. Each airport economic zone represents the most advanced, fastest and most distinctive industry in the region, and also orients the high-quality urban development. In the world, many countries are carrying out development and construction plans for "airport zones". The strategy and method of "time-critical value orientation" should be followed to improve the aerotropolis land use efficiency, attract "high value-added" industries, plan the integrated transport complying with the airport-related characteristics, and optimize the coordination mechanism inside and outside the airport.

In this paper, by generalizing and summarizing cases, it is deemed that the planning method of airport economic zone includes four aspects.

(1) Introduce airport industry and function oriented by 'time-critical'. First, time-critical value focuses on: the value generated by delivering products or services to customers in the global market in a very short period of time. Second, the orientation of "time-critical value" for the industry around an airport relates to: the speed to access global markets, the market agility of the product, and the connectivity to the global markets or supply chains.

(2) The site selection is mainly in its 'fast accessibility' to the airport runway. First, the core goal of the location of the airport economic zone is to maximize the "accessibility" to the airport, and to increase the "time-critical value" of land use from the site selection level. Second, it is not that the closer to the

airport fence, the easier to connect to the airport runway or terminal building; some airport economic zones are located near the fence but have to detour to the airport entrance; so the length of time to enter the airport is the key factor.

(3) Transportation should be beneficial to improving the 'connectivity' between airport economic zone and airport runway. First, freight distribution: truck transport completes "warehouse to client gates", multimodal containers complete "warehouse to warehouse" via rail lines. Second as for passenger transport, an integrated transportation system may be created by connecting the airport to highway, expressways, high-speed railway, and rail transit.

(4) Establish the corresponding 'collaborative mechanism' to realize the collaborative and efficient operation of airport, airport economic zone and city. In order to realize the internal and external collaboration between the airport and the airport-related economy, there are two common strategies: one is to promote collaborative development by a company jointly operated by the management entities inside and outside the airport; and the other is to establish a non-profit platform organization to assist the government in making decisions, attract investment and help enterprises select locations and settle in, and provide economically reasonable, market-worthy, high operation efficiency policies and suggestions in consideration of all interested entities.

References

- Cammen H van der & L de Klerk.(2003). Ruimtelijke Ordening: van grachtengordel tot VINEX-wijk. *Utrecht: Spectrum uitgeverij*.
- Jong Bart de. (2006). Schiphol Airport Amsterdam: to understand the past is to secure future economic growth. *European Regional Science Association 30-03 August/September 2006 Volos*, 46.
- Kasarda J. D. , Rondinelli D. A. & Ward J. W.. (1996). The global transpark network: Creating an infrastructure support system for agile manufacturing. *National Productivity Review*, p. 34-41.
- Dai Jianshe, and He Yong. (1995). 'Research on rapid transportation at multiple supply and demand points'. *Journal of Systems Engineering*.(3), 124-130.
- Yang ling. (2020). The south of "hub + opening" is "moving". Zhengzhou airport will strive to exceed 100 billion yuan of regional GDP this year. [Online] Available at: http://henan.china.com.cn/2020-05/21/content_41158901.htm [Accessed 10 september 2021].
- Amsterdam Airport Area. (2021). Home page. [Online] Available at: <http://www.aarea.nl/> [Accessed 10 september 2021].
- Gateway Gardens. (2021). Home page. [Online] Available at: <https://www.gateway-gardens.de/en/> [Accessed 10 september 2021].
- Liu Wujun. (2014). Study on airport land development. Shanghai: Shanghai Science and Technology Press.
- Shanghai Shenhong Investment Development Co., Ltd.. (2021). Home page. [Online] Available at: <http://www.sh-sr.com.cn> [Accessed 10 september 2021].