IMPACT ON PASSENGER AND CARGO FLOW CAUSED BY THE FUNCTIONAL DECLINE OF THE INTERNATIONAL AIRPORT

Dr. Hidefumi IKEDA
Research Coordinator for Advanced Airport Technology, Airport Department
National Institute for Land and Infrastructure Management (NILIM)

***ABSTRACT*:** Today, with the steady progress of globalization, the Japanese economic society would have vast impacts by the functional decline of the international traffic infrastructures, such as the international airports and seaports, in the case of large-scale earthquakes and so on. It is necessary, therefore in advance, to prepare and take management measures to meet the situation, which minimize the influence and secure the required level of functions of the international traffic network.

In order to study how to cope with such a situation, this paper deals with the followings;

1) Analysis on the current situation of Japanese international air transport
2) Collection and arrangement of risks related with the airport function
3) Formulation of the basic model to evaluate the influence on the international passenger and cargo flow in the case of the functional decline of the airport
4) Case study utilizing Narita International Airport

KEYWORDS: International Airport, Risk, Risk Management, Functional Decline, International Passenger and Cargo Flow

1. INTRODUCTION

Since Japan is an island nation, the international traffic infrastructures, such as the international airports and seaports, have played a vital role in international cargo and passenger flow over borders. The importance will continue to increase with the steady progress of globalization. Today, almost all international passengers use the airports, and no less than 30% of cargoes (by value) pass through the airports, even though 99% of cargoes (on a weight basis) are handled at the seaports. This study is the part of the overall management study to attempt to minimize the influence on the Japanese economies in such an event to bring about the decrease in function of the international airport.

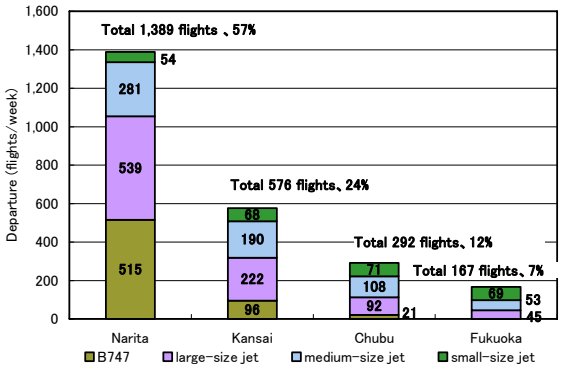
To begin with, characteristics of Japanese international air transport are analyzed, with Narita International Airport in the capital region, Kansai (in western Japan) and Chubu (in central Japan) International Airports and Fukuoka Airport (in Kyushu) to attract many regular flights (hereinafter called Narita, Kansai, Chubu (or, *Centrair*) and Fukuoka, respectively). ‘Risk’ related with the international airport is also investigated, utilizing recent annual security reports of corporations and so on. The term of ‘risk’ has a various kinds of meanings in a lot of fields. In this paper, however, ‘risk’ is defined as disturbing factor to the public safety and security, activities of corporations and organizations, and public infrastructures as the airports and seaports. In addition, concerned parties’

efforts to cope with the risk are reviewed. In order to evaluate the impact of the risk, as the essential part of the paper, the basic quantitatively-model is formulated concerning the international passenger and cargo flow in the case of the functional decline of the airport. Finally, a case study as to Narita International Airport is carried out, utilizing the model. The outcome is impressively fruitful, for the further steps in the future.

2. CURRENT SITUATION OF INTERNATINAL AIR TRANSPORT

2.1 International Air Passenger

In Figure 2.1, international passenger flights are orderly disposed by airport and by type of aircraft (B747, large-, medium- and small-size jet). Around 57% of total regular flights at four airports are connected to Narita, while 24% to Kansai, 12% to Chubu and 7% to Fukuoka. In addition, Narita flights consist of larger aircrafts (B747 and large-size jet, 76%). Moreover, Narita play an important role in forming networks with North, Central and South America and Europe. Seat numbers in service are calculated in Figure 2.2.



Note : As of June 2005
Source : JTB flight schedule

Figure 2.1 International Passenger Flights

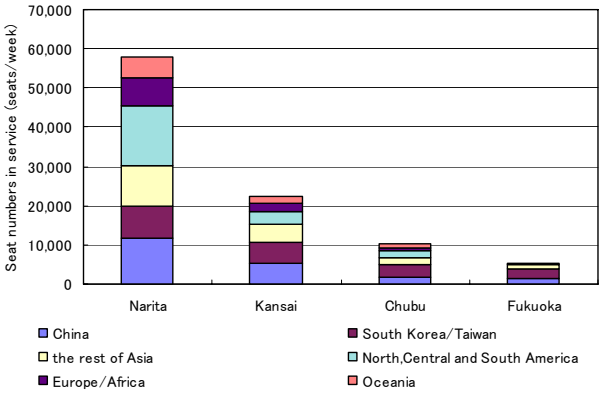
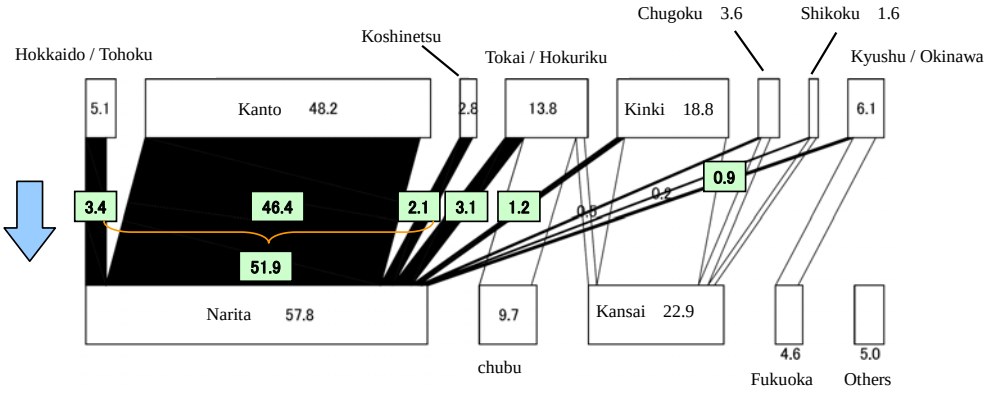


Figure 2.2 Seat Numbers in Service

As to Japanese passenger flow, Narita is utilized by around 60% of the total, mainly from Kanto region (80%). Trip objectives are sightseeing (60%, distinguishing), business (20%) and others (20%). Share of destinations from Narita is relatively higher for North, Central and South America and Europe/ Africa than the other airports are (Figure 2.3 and 2.4).



Note : fignres in %
Source : Dynamic survey in 2005 on international air passenger

Figure 2.3 Airports and Passenger Flow

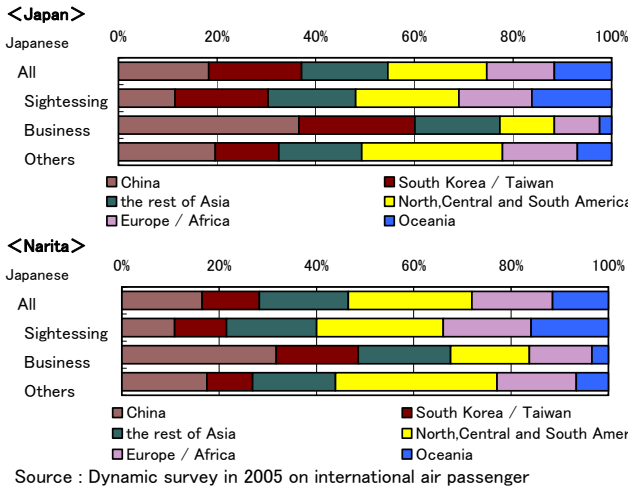
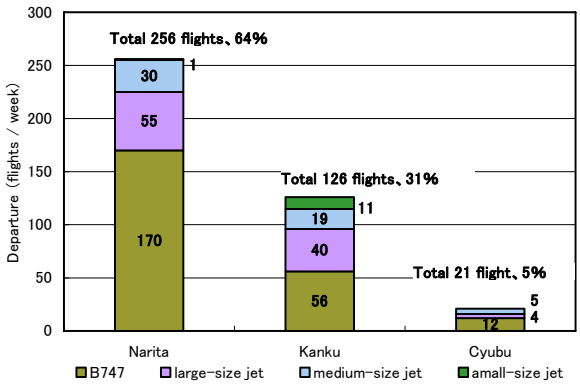


Figure 2.4 Passenger Destinations

2.2 International Air Cargo

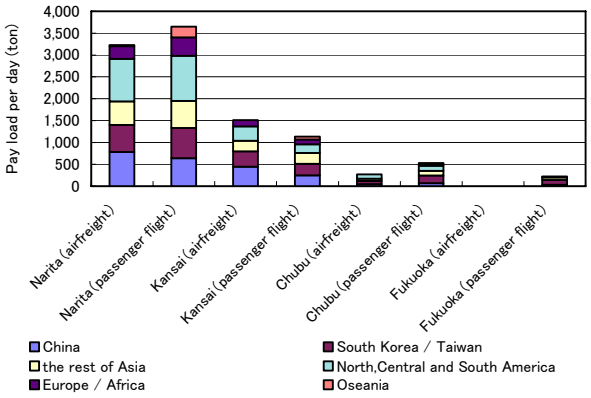
Around 64% of the total regular airfreights at four airports are connected to Narita, while 31% to Kansai and 5% to Chubu (no regular airfreights to Fukuoka). Narita airfreights consist of larger aircrafts (B747 and large-size jet, 88%) than passenger flights (Figure 2.5). Narita occupies 70% share of networks with North America and Europe. Load capacity of both airfreights and passenger flights is estimated in Figure 2.6.

Concerning the export of cargo flow, Narita's share is around 60%, originated mainly from Kanto region (50%) and Tokai/ Hokuriku region (20%). Cargoes are mechanical components (80%) and chemical products (10%), which go out directly from factories (70%) and from warehouses (30%). Those are mainly for North, Central and South America (30%) and China, South Korea/ Taiwan and Europe/ Africa (20%, respectively) (Figure 2.7 and 2.8).



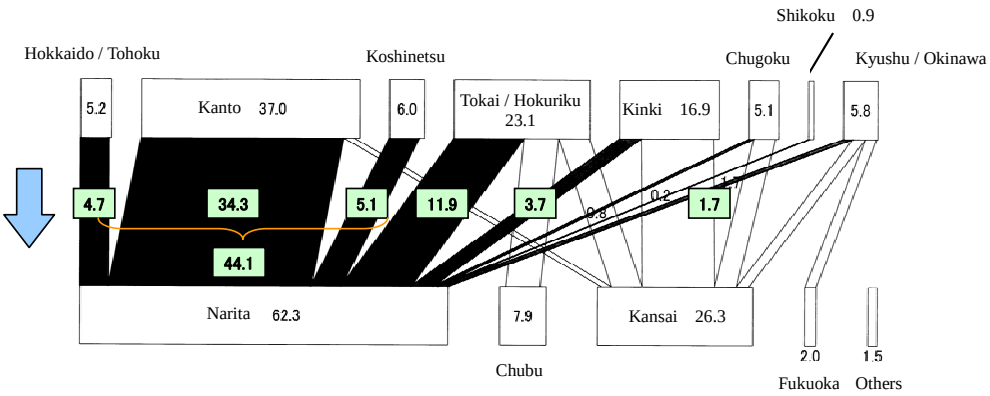
Note : As of June 2005
Source : Fuji Airways Guide

Figure 2.5 International Regular Airfreights



Source : Based on ICAO TFS data

Figure 2.6 Cargo Destinations



Note : fignres in % on a wight bases

Source : Trade Statisties of Japan in 2005 (Ministry of Finance)

Figure 2.7 Airports and Cargo Flow (Export)

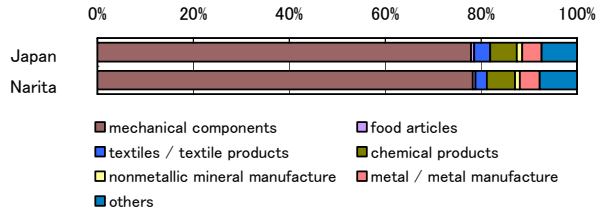
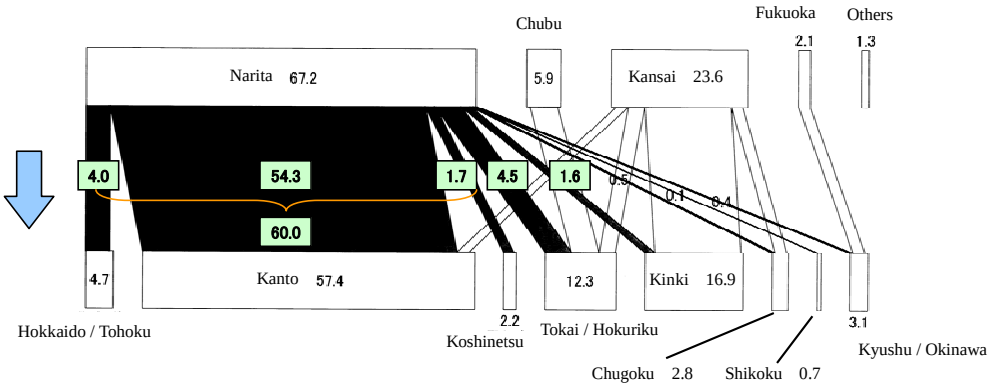


Figure 2.8 Cargo Items (Export)

As to the import of cargo flow, Narita's share is also around 70%, originated mainly to Kanto region (80%) and Tokai/ Hokuriku region (10%). Cargoes are mechanical components (40%), food articles (20%) and textiles/ textile products (20%), large portion of which seem to be consumer goods. Those are carried in warehouse (50%) and factories (30%), and originated mainly from China (40%), North, Central and South America (20%) and Europe/ Africa (20%) (Figure 2.9 and 2.10).



Note : fignres in % on a wight bases

Source : Trade Statisties of Japan in 2005（Ministry of Finance）

Figure 2.9 Airports and Cargo Flow (Import)

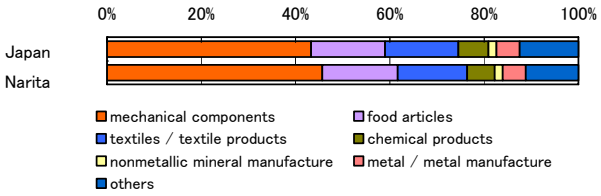


Figure 2.10 Cargo Items (Import)

3. RISK RELATED WITH THE AIRPORT FUNCTION

In Japan, corporations and organizations have begun to disclose risks, which could impact or bring down them, in annual security reports since 2004. Based on the reports of airport corporations, airlines, forwarders and consignors, risks related with the airport function are extracted and classified as shown in Table 3.1. Then, the relationship between their occurrence frequency and the corresponding period of functional decline of the airport are analyzed (Figure 3.1). Roughly speaking, natural threads such as heavy snow, heavy typhoons/ tidal wave, massive earthquakes/ tsunamis are to be paid much attention, which might also influence the neighboring region of the airport a lot.

Table 3.1 Risks Related with the Airport Function

Break down	Risk factor
○Natural disaster	earthquake / tsunami, tyhoon /tidal wave, heavy snow, rising sea levels,（lighting strike）,（heavy fog）
○Accident	system failure , defect of hardware or software , blackout, equipment failure,（fire）,（aircraft accident）
○Incident	terror / cyberterrorism,（hijack）,（blasting）,（break-in）
○Labor issue	strike
○International affairs	international conflict, war, rioting, worsening political climate
○Surroundings	epidemic
○Lawsuit	filing for an injunction against the service
○Maintenance	ground settlement,（repair work）

Note :（other risk factors）supposed aside from collected annunal security reports

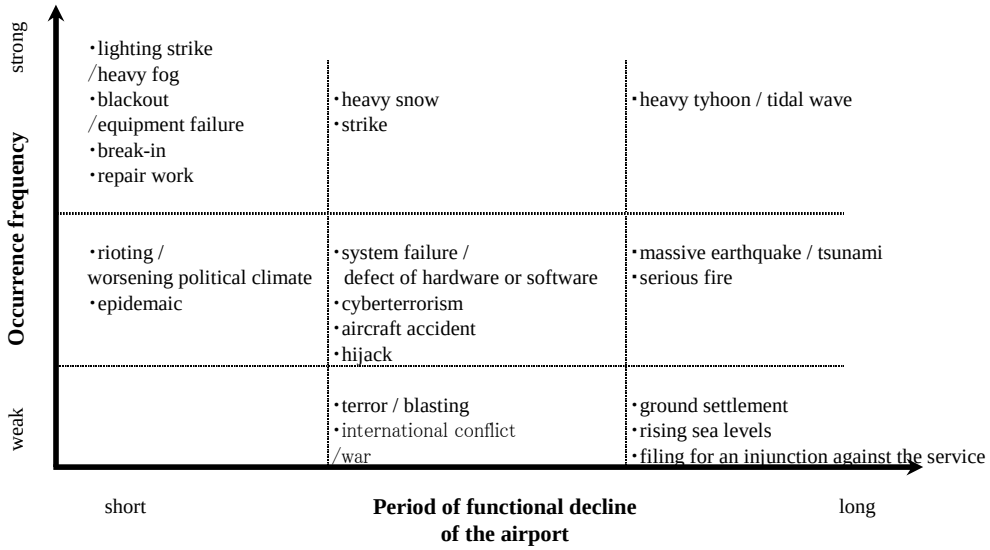


Figure 3.1 Relationship between Occurrence Frequency and Functional Decline Period

4. CURRENT EFFORT AND APPROACH OF OFFICAL AND RERATED PARTIES

As part of a continuing effort to cope with disasters, Japanese government sets up the Central Disaster Prevention Council at the Cabinet Office. Its 2008FY priority plan for disaster prevention emphasizes the strategic challenge to contain the damage by large-scale disasters, the improvement of disaster-proof social infrastructures in Japan, where many kinds of natural disasters such as earthquakes/ tsunamis, wind and flood damage, landslide disaster, etc. occur frequently, and other measures.

Its expert panel on the near-field earthquake in the capital region has studied the countermeasures to secure the capital functions in the event. Concerning the airports, post-disaster situation shall be checked up within one hour, and the operation is gradually started, utilizing runways and others with emergency steps. As well, the expert panel on the upgrading actions of disaster prevention by private-sector and market vitality has organized “the Business Continuing Guideline” and related materials. It recommends that an earthquake is better to be

assumed as threat to begin with, and the coping process is easily able to expand in application.

The Ministry of Land, Infrastructure and Transport has emphasized the safety and security of our country and transport, which was especially obvious, for example, as a subtitle of the white book of 2006FY. It treated various kinds of threats such as natural disasters, accidents/ troubles, terrors, etc. In 2006, the outline plan of measures for disasters focused on software information role at ordinary times and in times of disasters or accidents. In addition in 2007, the Ministry prepared its own BCP (Business Continuing Plan). At the same time, the Civil Aviation Bureau organized the report, “Earthquake-proof Airport in the Future.” The important airports in air transportation shall be able to be in operation for regular commercial flight services within three days after the disaster, and the operation shall be equivalent to 50% of ordinary times in scale as early as possible.

To that end, private sector has begun to prepare the BCP. Some major forwarders and consignors (manufacturers) recognize that transportation capacity would fall down to 30-60% even with Chubu, Kansai and others in the case of breakdown of the existing Narita, that semiconductors or long distance cargoes for Europe/ North America could not alternated to sea transport, and that industrial plants would be fatally damaged in the three days’ absence of SC (supply chain).

5. ANALYSIS ON THE IMPACT CAUSED BY THE FUNCTIONAL DECLINE OF THE INTERNATIONAL AIRPORT

5.1 Basic preconditions

The impact on the international passenger and cargo flow, caused by the functional decline of the airport is analyzed quantitatively. The methodology is as simple as possible, to bring sharp results. In this paper, the fact of the functional decline of the airport is only employed, that is to say, the kinds of threats are not considered for some time to come (for example, however, easily applied to the earthquake case). The necessary demand for the functionally declined airport will be alternatively dealt by the remaining three airports. The corresponding capacity to that demand of each airport is estimated as the margin (difference) between the current capacity and the used (current) demand. At this time, it is not taken into account in a practical sense, that critical materials are handled in emergency case. It is why this paper focuses on the ordinary business continuity of concerned parties.

5.2 Necessary demand to be assured

For passenger and cargo, some basic cases are assumed and set up respectively, as referred to hereinafter.

5.2.1 Passenger demand (Passenger Case 1 and 2)

Business passengers will not cancel the trip in the event. Sightseeing passengers abroad shall be accepted to return home. Others cancel the trip. That is, Japanese are to be considered only for entry into Japan, while non-Japanese are only for departure from Japan. Transit passengers use other available airports. Case 1 is for the departure from the airport and 2 is for the arrival as shown in Table 5.1.

Table 5.1 Necessary Demand of Passenger

Passenger Case 1（departure）

	business	sightseeing	others	transit
Japanese	covered	–	–	–
non-Japanese	covered	covered	–	–

Passenger Case 2（entry）

	business	sightseeing	others	transit
Japanese	covered	covered	–	–
non-Japanese	covered	–	–	–

5.2.2 Cargo demand (Cargo Case 1 and 2)

All cargoes presently handled at the airport are necessary to be dealt at the remaining three airports (Cargo Case 1). As part of all cargoes, mechanical components are intended as scope of target (Cargo Case 2). They occupy the major part of cargoes as described beforehand in Japan, and depend on air rather than sea (30% of export and 60% of import by value in recent years).

Table 5.2 Necessary Demand of Cargo

	scope of target
Cargo Case 1	all cargoes
Cargo Case 2	mechanical components

5.3 Changing influence with the functional recovery of the airport

Several kinds of scenarios for the airport to functionally recover could be assumed. In this paper, however, one typical scenario is drawn up and analyzed. (Other scenarios are relatively easily studied based on this method.)

The assumed scenario

The functional level of it will reach 50% in one week after the breakdown, and be full-fledged in service in three weeks after the time (that is, in one month after the breakdown) as in Figure 14. When the airport is functional at 50%, the remaining 50% demand shall be dealt with by the remaining three airports and a new surplus, the difference between 50% functional capacity of the airport and 50% demand handled there.

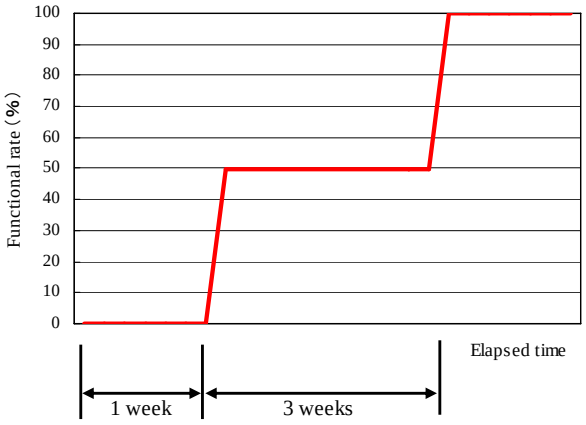


Figure 5.1 Recovery Scenario of the Airport

5.3 Formulation of the basic model to evaluate the influence on the international passenger and cargo flow

The formulated model is shown as in Figure 5.2. Four objective international airports are **A**, **B**, **C** and **D**. **D** is the airport to be functionally declined by some threads. Current demand at each airport is D, while existing capacity is S. For example, the current demand at **D** airport is expressed as $D_{\mathbf{D}}$, and the existing capacity is $S_{\mathbf{D}}$. The way is the same for the other airports, too.

To begin with, when the **D** airport is broken down ($S_{\mathbf{D}} = 0$, the functional recovery rate $\alpha = 0\%$), the necessary demand $D'_{\mathbf{D}}$ at the **D** (②) will be dealt with by the total of the margin capacity of the other **A**, **B** and **C**, $C_{0\mathbf{A},\mathbf{B},\mathbf{C}}$(①). If ① is larger than ②, $D'_{\mathbf{D}}$ is cleared, and otherwise, the difference of ②-① will be resident. After the residence lasts for β days, the accumulated volume will be calculated by multiplying ②-① and β. Similarly, the margins of①-②($\geqq 0$) sums up for γ days. When the former figure is smaller than the latter, all the residence will be resolved in the duration of $\beta + \gamma$ days.

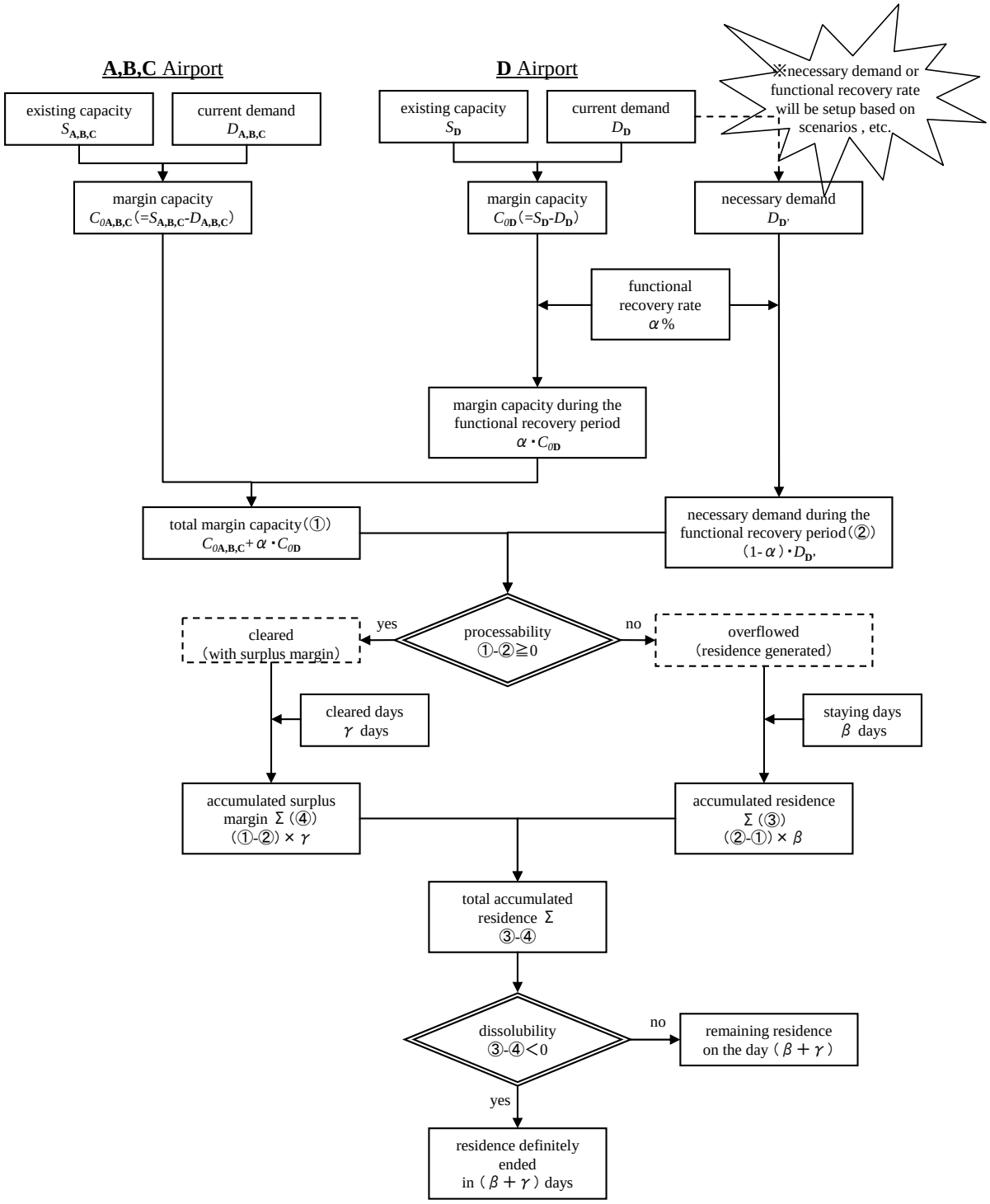


Figure 5.2 Formulated Model

6. C ASE STUDY ON NARITA INTERNATIONAL AIRPORT

Based on the basic preconditions and model in the previous chapter, Narita is employed for the airport of the case study concerning the impact caused by its break down and functional recovery. Passenger Case 1 and 2, and Cargo Case 1 and 2 are analyzed and assessed. The necessary demand (passenger and cargo) not to be handled at Narita will be dealt with by Kansai, Chubu and Fukuoka.

61 Impact on passenger flow at the breakdown

The necessary demand is shown in Table 6.1, where Passenger Case 1 is on the left, while Case 2 is on the right. These figures are based on the average day passengers at Narita, and destinations and origins are considered.

Table 6.2 is the result, where the necessary demand is dealt with the remaining three airports. Their margin capacity is calculated as the difference between the number of seats of aircrafts (Load Factor =100% and 90% assumed) and the current passenger volume. The positive figures in the column of processability means *just cleared*, while the negative figures *still overflowed*. Even in the case of LF=100%, leaving passengers are left behind for North, Central and South America, and Europe/ Africa for which Narita attracts many service lines at present. As to arriving passengers, of whom a lot of Japanese sightseers occupy a considerable portion, almost all figures are negative.

Table 6.1 Necessary Demand of Passengers

Total departure (*Passenger Case 1*)	11,900	100%	Total entry (*Passenger Case 2*)	24,460	100%
Japanese / business	5,480	46%	Japanese / business	5,480	22%
non-Japanese / business	3,320	28%	non-Japanese / business	3,320	14%
non-Japanese / sightseeing	3,100	26%	Japanese / sightseeing	15,660	64%
destination	11,900	100%	origin	24,460	100%
China	2,970	25%	China	3,990	16%
South Korea / Taiwan	3,240	27%	South Korea / Taiwan	3,650	15%
the rest of Asia	1,750	15%	the rest of Asia	4,490	18%
North , Central and South America	1,940	16%	North , Central and South America	5,480	22%
Europe / Africa	1,650	14%	Europe / Africa	4,130	17%
Oceania	350	3%	Oceania	2,720	11%

Table 6.2 Impact on Passengers

Departure (*Passenger Case 1*)	necesarry demand (passengers / day)	total margin capacity of three airports			
		LF=100%		LF=90%	
	11,900	13,180	processability	9,380	processability
China	2,970	4,200	1,230	3,320	350
South Korea / Taiwan	3,240	3,580	340	2,500	-740
the rest of Asia	1,750	2,960	1,210	2,240	490
North , Central and South America	1,940	1,070	-870	520	-1,420
Europe / Africa	1,650	570	-1,080	320	-1,330
Oceania	350	800	450	480	130
		overflowed	-1,950	overflowed	-3,490

Entry (*Passenger Case 2*)	necesarry demand (passengers / day)	total margin capacity of three airports			
		LF=100%		LF=90%	
	24,460	13,040	processability	9,240	processability
China	3,990	4,150	160	3,270	-720
South Korea / Taiwan	3,650	3,490	-160	2,410	-1,240
the rest of Asia	4,490	2,880	-1,610	2,160	-2,330
North , Central and South America	5,480	1,140	-4,340	590	-4,890
Europe / Africa	4,130	590	-3,540	340	-3,790
Oceania	2,720	790	-1,930	470	-2,250
		overflowed	-11,580	overflowed	-15,220

62 Impact on cargo flow at the breakdown

Shown in Table 6.3 as passenger cases are Cargo Case 1 in the fist row, and Cargo Case 2 in the second. Export is on the left, and import on the right. Breakdowns in the lower half are destinations and origins of Cargo Case1.

Marginal capacity is estimated to be equivalent to the LF'=+30% or +20% of the current daily average cargo volume at each airport. The impact is shown in Table 6.4. For Cargo Case 1, almost all figures mean to run short. The fact is realized again, needless to say, of the importance of Narita in the present Japan. Even for Cargo Case 2, almost all figures are still negative especially in export, since the mechanical components occupy as much as 80% of Japan's export. In import, the rate drops down to some 40%, but some cargoes from China or Europe/ Africa aren't brought to Japanese market.

63 Changing influence on passenger flow with the functional recovery

Passenger Case 1 is shown in the upper half figures of Figure 6.1. Only the initial four week's influences are shown, followed by the release of all the residence afterwards. The passengers who can't leave for North, Central and South America or Europe/ Africa increase during the first week, but they will gradually depart with the functional recovery of Narita.

As well, Passenger Case 2 is in the lower half. Almost all lines, including North, Central and South America, Europe/ Africa or Oceania, aren't able to serve the arriving passengers well.

Table 6.3 Necessary Demand of Cargoes

unit : ton / day

Total export (*Cargo Case 1*)	2,310		Total import	2,630	
mechanical components	1,750		mechanical components	1,160	
of the total (%)	76%		of the total (%)	44%	
(*Cargo Case 2*)					
destination	2,310	100%	origin	2,630	100%
China	510	22%	China	970	37%
South Korea / Taiwan	410	18%	South Korea / Taiwan	260	10%
the rest of Asia	360	16%	the rest of Asia	380	14%
North , Central and South America	600	26%	North , Central and South America	480	18%
Europe / Africa	400	17%	Europe / Africa	470	18%
Oceania	30	1%	Oceania	70	3%

Note : figures in destination or origin are for total export or import, respectively.

Table 6.4 Impact on Cargoes

total (Cargo Case 1)	necessary demand (ton / day)	total margin capacity		processability						overflowed (ton / day)
		LF'	(ton / day)	China	South Korea / Taiwan	the rest of Asia	North , Central and South America	Europe / Africa	Oceania	
export	2,310	+30%	1,040	-250	-120	-160	-410	-330	0	-1,270
		+20%	740	-340	-220	-230	-440	-340	0	-1,570
import	2,630	+30%	1,140	-700	30	-150	-250	-380	-40	-1,520
		+20%	790	-800	-50	-220	-320	-410	-40	-1,840
mechanical components (Cargo Case 2)										
export	1,750	+30%	1,040	-130	20	-50	-280	-260	-10	-730
		+20%	740	-220	-80	-120	-310	-270	-10	-1,010
import	1,160	+30%	1,140	-260	140	30	100	-60	30	-320
		+20%	790	-360	60	-40	30	-90	30	-490

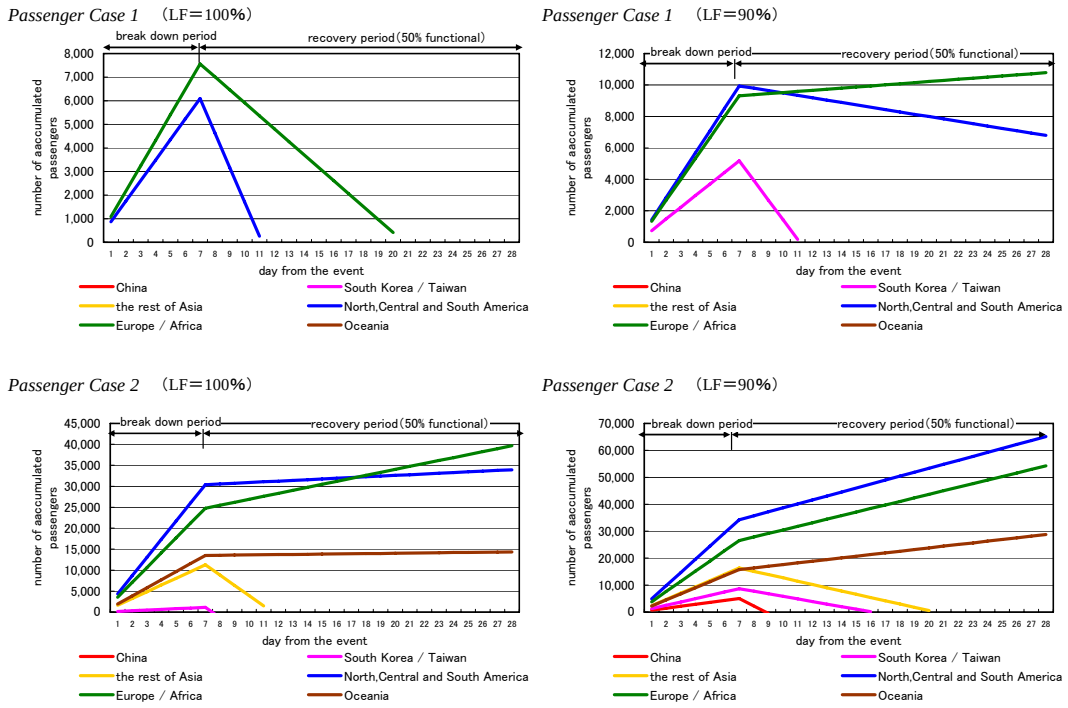


Figure 6.1 Changing Influence on Passengers

64 Changing influence on cargo flow with the functional recovery

Cargo Case 1 is shown in Figure 6.2. The cargoes for Europe/ Africa, distinctive to Narita, aren't exported and imported at full value, and additionally from China in import. In turn, Case 2 is in Figure 6.3. Compared with Case 1, the congestion is less, but the export to Europe/ Africa would be still affected.

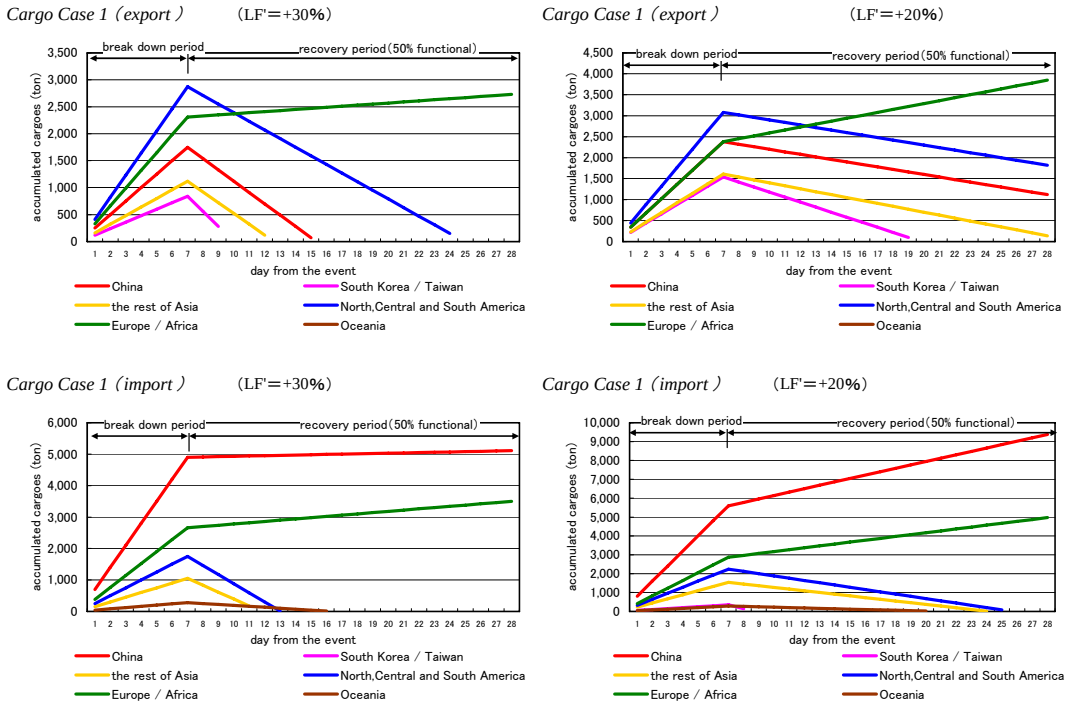


Figure 6.2 Changing Influence on Cargoes

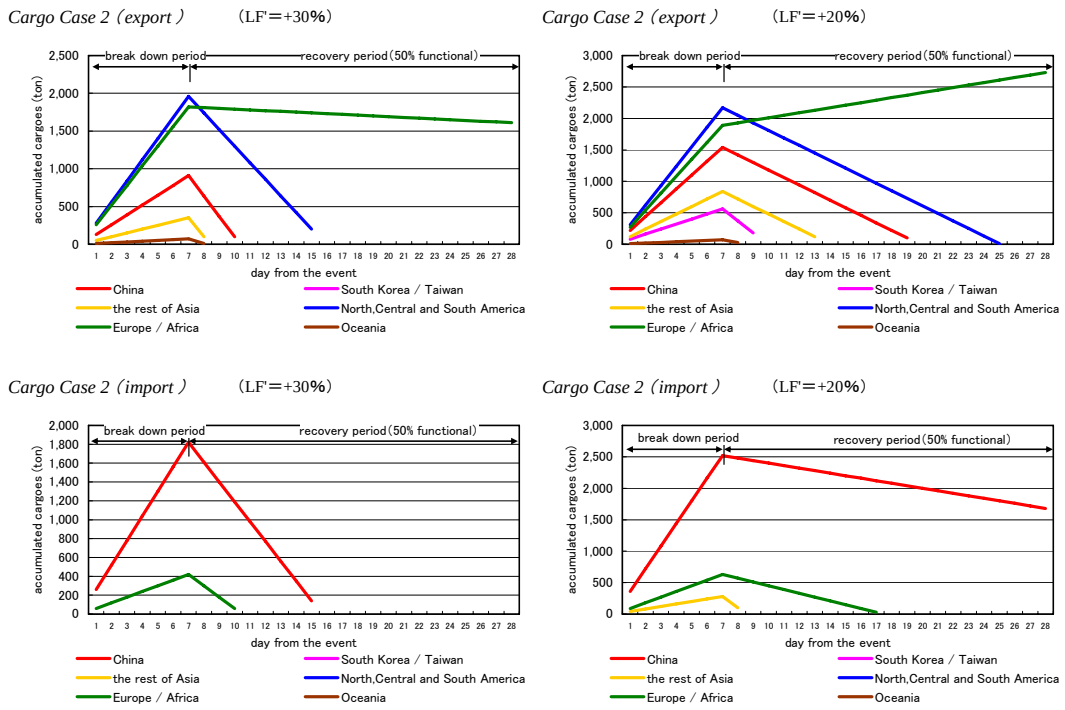


Figure 6.3 Changing Influence on Mechanical Components

7. CONCLUSIONS AND FUTURE DEVELOPMENTS

After the current situation of Japanese international air transport and risks related with the airport function reviewed, the basic model to evaluate the influence on the international passenger and cargo flow in the case of the functional decline of the airport was formulated. Narita was employed for the case study, and the impact was clearly described and analyzed.

The evaluation is simple, but the outcome is very fruitful. With this conclusion, concerned parties are expected to strengthen cooperation one another and prepare proper countermeasures for the time to come. At the same time, the study will continued to be developed into the next stage, including the refinement and extension of the above model with having comments from the field, and so on.

REFERENCES

Annual security reports of airport corporations, airlines, forwarders and consignors in Japan

H. Ikeda, T. Ishikura, M. Nishimoto and T. Koizumi, Basic Study on the Functional Decline of the International Airport - Related with Risk and Air Transport -, *Technical Note of NILIM*, No.421, 2007 (Journal Articles)

M. Abe, An Examination on Management Policy of Global Logistics Infrastructure, With a View to Supporting Business Continuity, *Technical Note of NILIM*, No.337, 2007 (Journal Articles)

Mitsubishi Research Institute, Inc., *Risk Management Guide*, Japanese Standards Association, 2000 (Book)

Risk Management of Ports, *Ports and Harbours*, The Japan Port & Harbour Association, Vol 83, 2006 (Review Journal)

Website References of Cabinet Office, the Ministry of Land, Infrastructure and Transport and so on