Adaptive Policymaking for Airport Strategic Planning

J. H. Kwakkel, W.E. Walker, and V.A.W.J. Marchau

Abstract—Airport Strategic Planning (ASP) focuses on the development of plans for the long-term development of an airport. A crucial challenge in ASP is how to deal with uncertainty about relevant future developments (e.g., aviation demand, the oil price, strategic alliances, the regulatory context, technological breakthroughs, etc.). Currently, ASP usually focuses on reducing demand uncertainties through aviation forecasting. However, forecasting has received a lot of criticism. Since most uncertainties are ignored, the forecasts are practically always wrong. Still, most airports base their plans on a single forecast. As such, current ASP practice often results in serious negative consequences for the long-term development of an airport, including an inability to implement the plan, severe capacity constraints due to unanticipated (noise) regulations, an inability to meet the actual demand, and unnecessary investments in airside and landside facilities. An alternative for handling uncertainty in ASP involves adaptive policymaking. Adaptive approaches take immediate actions that might be needed right away and create a framework for future actions that allow for adaptations over time as knowledge about the future becomes available and critical events for implementation take place. In this paper we describe the problem of uncertainty in ASP in more detail, present an example of the application of adaptive policymaking to the case of Schiphol Airport, and discuss the strengths and weaknesses of this approach for developing plans that address the uncertainties airports face. We conclude that adaptive policymaking is a highly promising alternative to traditional forecasting-based approaches, and show how its application might prevent future mistakes in airport planning.

I. INTRODUCTION

Airport Strategic Planning (ASP) focuses on the development of plans for the medium and long term development of an airport. Strategic planning is defined as ‘the managerial activities that produce fundamental decisions and actions that shape and guide what the organization is, what it does, and why it does it’ [1]. Strategic planning can be done in many different ways. In airports, the dominant approach is Airport Master Planning (AMP), which results in a Master Plan that ‘presents the planner’s conception of the ultimate development of a specific airport’ [2].

A crucial challenge in ASP is how to deal with uncertainty about the future. In order to make decisions that shape and guide what an organization is, what it does, and why it does it, it is necessary to take into account the future world in which the organization will operate. In case of ASP, uncertainty is even more important, given the fact that decisions made today can shape and influence the airport performance for many years to come. For example, the decision to build a new runway on a specific location will likely influence the airport more than fifty years from now. A thorough assessment of potential developments that can influence the future in which the airport will operate is therefore necessary, if one wants to plan effectively. In AMP, however, only demand uncertainties are considered through a single aviation demand forecast.

AMP and demand forecasting as the approach for the treatment of uncertainty in ASP has come under increasing criticism [3-5]. The demand forecasts are practically always wrong, and Master Plans are often near impossible to implement. As such, AMP often results in serious negative consequences for the long-term development of an airport.

Alternative approaches for the treatment of uncertainty in Airport Strategic Planning include scenario approaches which try to identify a robust policy across a set of plausible futures; and adaptive approaches which take actions that are needed right away and create a framework for future actions that allow for adaptations over time, as knowledge about the future becomes known and critical events for implementation take place. In this paper, we explore how adaptive policymaking can help in the treatment of uncertainty in ASP.

The structure of this paper is as follows: in the next section, we describe the problem of uncertainty in ASP in more detail. In section 3 we describe adaptive policymaking in more detail. An illustration of the adaptive approach to ASP is given in section 4, using Schiphol Airport as a case study. Section 5 presents the conclusions.

II. THE CURRENT PRACTICE OF AIRPORT MASTER PLANNING

Airport Strategic Planning (ASP) focuses on the development of plans for the long-term development of an airport. A crucial challenge in ASP is how to deal with uncertainty about relevant future developments (e.g., aviation demand, the oil price, strategic alliances, regulatory context, technological breakthroughs, etc.). Currently, ASP only focuses on reducing demand uncertainties through aviation demand forecasting. Since most uncertainties are ignored, aviation demand forecasts are practically always wrong. Still, most airports base their plans on a single forecast. As such, current ASP practice often results in serious negative consequences for the long-term development of an airport, including an inability to implement the plan, severe capacity constraints due to unanticipated regulations (e.g., noise), an inability to meet the actual demand, and unnecessary
investments in airside and landside facilities. For example, when the new Denver Airport opened in 1995, it had excess capacity due to wrong aviation demand forecasts.

A general definition of uncertainty is 'any departure from the unachievable ideal of complete determinism' [6]. Uncertainty is not simply a lack of knowledge, since an increase in knowledge might lead to an increase of knowledge about things we do not know, and thus increase uncertainty. Recently, there has been increasing interest in deep uncertainty. Deep uncertainty is a condition in which the decisionmaker does not know, or multiple decisionmakers cannot agree on, the system model, the prior probabilities for the uncertain parameters of the system model and/or the value function [7]. The traditional way to deal with uncertainty in airport planning is through the use of AMP: based upon a single forecast of future traffic demand, a static plan is designed that is assumed to be able to accommodate the forecasted traffic demand in an adequate way. It is also assumed that the airport authorities are able to implement the plan without any opposition from other stakeholders [8].

A. Master Planning

AMP is the process of developing a Master Plan. According to ICAO, the United Nations body for civil aviation, ‘an airport Master Plan presents the planner’s conception of the ultimate development of a specific airport’ [2]. This definition is also used by the International Air Transport Association (IATA) [9]. According to the FAA, the United States regulator of aviation, ‘an airport Master Plan is a comprehensive study of the airport and typically describes short, medium, and long-term plans for airport development’ [10], which is almost identical to the ICAO definition. In the U.S., the FAA has set up strict guidelines for AMP [10]. Internationally, reference manuals of IATA and books about airport planning by leading scholars heavily influence AMP practices [e.g. 2, 9, 11].

The goal of a Master Plan is to provide a blueprint for future airport developments. As such, it describes the strategy of an airport operator for the coming years, without specifying operational concepts or management issues [8, 12]. A typical Master Plan, according to the FAA, should contain (i) a technical report containing the analyses conducted during the development of the Master Plan; (ii) a summary report that brings together facts, conclusions and recommendations relevant to a wider public; (iii) an airport layout plan drawing set which contains a graphical representation of the proposed developments in the Master Plan; and (iv) a website and public information kit for providing information about the Master Plan to the public [10]. The time horizon covered in a Master Plan can vary depending on the situation of the airport for which a Master Plan is developed. A short-term Master Plan has a time horizon up to roughly 5 years, a mid-term Master Plan has a time horizon of 6 to 10 years, and a long term Master Plan has a time horizon of 10-20 years [10].

Traditional AMP follows a linear process. The most commonly used guidelines [i.e. 2, 9, 10] are fundamentally the same, although they differ in detail [11]. These guidelines evolved out of ideas in the field of policy analysis (or systems analysis) [10, 11, 13]. According to these sources, the key steps in an AMP process are:

- Analyze existing conditions at the airport
- Make a demand forecast for future traffic demand
- Determine facility requirements needed to accommodate the forecasted aviation demand
- Develop and evaluate several alternatives to achieve the required facility requirements
- Develop the best alternative into a detailed Master Plan

The aviation demand forecast is the basis for a new Master Plan. An aviation demand forecast can be a forecast for the number of passengers, the tons of goods, or the number of air transport movements. Although the forecast usually contains information concerning all three. (For example, the forecast used for the key spatial development of Schiphol in 1995 was a forecast of aviation demand in terms of passengers. Given the average number of passengers on an airplane, this was translated into air transport movements.) By comparing the forecast with the existing conditions on an airport, an assessment can be made whether there is a need for new or expanded facilities. As such, aviation demand forecasting is the main way in which uncertainties about the future context in which an airport operates are handled. The basic concept of developing an aviation demand forecast is simple: past trends, based on time series or theories about underlying mechanisms, are identified and extrapolated forward. In mathematical terms, a relationship between independent variables (X1, X2, …, Xn) and the dependent variable (Y) is developed that matches with aviation demand observed in the past. The resulting model is then used for extrapolation in order to obtain a forecast for the year of interest [14].

We started this section from the observation that the treatment of uncertainty about the future is a crucial challenge in ASP, since decisions made today will shape and influence the airport performance for many years to come. A thorough assessment of potential developments that can influence the future in which the airport will operate is therefore necessary if one wants to plan effectively. In AMP, however, only demand uncertainties are taken into account, which are treated by aviation demand forecasting. Given the fact that only a single uncertainty is treated, AMP has proven to be ineffective, as can be seen for example in planning failures at Schiphol, Denver Airport, and Boston Logan. The key spatial planning decision Schiphol of 1995, with a time horizon of 20 years was obsolete in 1999 due to unanticipated rapid growth of aviation demand [15]. The new Denver Airport was developed because of anticipated growth, which never materialized. The new Airport ended up with fewer air transport movements then the old airport [12, 15, 16]. Boston Logan planned and started the construction of a new runway...
In the early 1970’s, but due to unanticipated changes in regulations, they were unable to open this runway until 2006 [15, 17-19]. Given the ongoing transition of the aviation industry from a state owned and state run enterprise to a market situation, the number and severity of the uncertainties is only expected to increase. In light of this, Master Planning becomes even less appropriate for long term airport planning and the identification and analysis of alternative approaches has become more urgent.

III. THE ADAPTIVE APPROACH

Initial ideas on adaptive policies are found early in the 1900s. Dewey [20] put forth an argument proposing that ‘policies be treated as experiments, with the aim of promoting continual learning and adaptation in response to experience over time’. However, there is very little in the literature relating directly to the topic of adaptive policies [21]. Only recently, [22] developed a specific, stepwise approach for adaptive policymaking. This approach allows implementation to begin prior to the resolution of all major uncertainties, with the policy being adapted over time based on new knowledge. It is an innovative way to proceed with implementation of long-term (transport) policies despite the uncertainties. The approach makes adaptation explicit at the outset of policy formulation. Thus, the inevitable policy changes become part of a larger, recognized process and are not forced to be made repeatedly on an ad-hoc basis. Adaptive policies combine actions that are time urgent with those that make important commitments to shape the future, preserve needed flexibility for the future, and protect the policy from failure. Under this approach, significant changes in the transportation system would be based on a policy analytic effort that first identifies system goals, and then identifies policies designed to achieve those goals and ways of modifying those policies as conditions change. Within the adaptive policy framework, individual actors would carry out their activities as they would under normal policy conditions. But policymakers, through monitoring and mid-course corrections, would try to keep the system headed toward the original goals. Figure 1 illustrates the adaptive policy process. In particular, the following steps summarize the process for creating and implementing an adaptive policy.

Figure 1: The adaptive policymaking process (adapted from Walker et al., 2001).

Both the first and the second steps are basically the same steps as are used currently in policy formulation. The first step constitutes the stage-setting step in the policymaking process (e.g. analyzing the existing conditions of an airport). This step involves the specification of objectives, constraints, and available policy options (e.g. expand the terminal, building a new terminal, adding a new runway, or extending an existing one). This specification should lead to a definition of success, i.e. the specification of desirable outcomes (e.g. desired noise levels, number of houses in noise contours, number of air transport movements served at the airport, minimal delay of aircrafts). In the next step, a basic policy is assembled, consisting of the selected policy options and additional policy actions, together with an implementation plan. It involves (a) the specification of a promising policy and (b) the identification of the conditions needed for the basic policy to succeed. These conditions should support policymakers by providing an advance warning in case of the failure of policy actions.

In the third step of the adaptive policymaking process, the rest of the policy is specified. These are the pieces that make the policy adaptive. This step is based on identifying in advance the vulnerabilities of the basic policy (the conditions or events that could make the policy fail), and specifying actions to be taken in anticipation or in response to them. This step involves (a) the identification of the vulnerabilities, (b) defining actions to be taken immediately or in the future, and (c) defining signposts that should be monitored in order to be sure that the underlying analyses remain valid, that implementation is proceeding well, and that any needed policy interventions are taken in a timely and effective manner.

Vulnerabilities are possible developments that can degrade the performance of a policy so that it is no longer successful. Actions are defined related to the type of vulnerability and when the action should be taken. Both certain and uncertain vulnerabilities can be distinguished. Certain vulnerabilities (e.g. an increase in noise levels) can be addressed by implementing mitigating actions – actions taken in advance to reduce the certain adverse effects of a policy (e.g. sound insulations). Uncertain vulnerabilities are handled in two ways. First, by implementing hedging actions – actions taken in advance to reduce or spread the risk of possible adverse effects of a policy. Second, by specifying possible future actions. For the latter vulnerabilities, signposts are defined and a monitoring system established to determine when actions are needed to guarantee the progress and success of the policy. In particular, critical values of signpost variables (triggers) are specified, beyond which actions should be implemented to ensure that a policy keeps moving the system in the right direction and at a proper speed. Note that, apart from vulnerabilities to the basic policy, opportunities might also be considered in this step. Opportunities are external developments that can constitute an improvement of the performance of a policy so that it is more successful than it would have been without these external developments. These opportunities should be monitored as well in order to take advantage of the developments and, for instance, expand the basic policy (e.g. assuming noise insulation is part of the basic policy, if the costs turn out to be lower, more houses could be included).

Once the basic policy and additional actions are agreed upon, the final step involves implementation. In this step, the
actions to be taken immediately are implemented and a monitoring system is established. Then time starts running, signpost information related to the triggers is collected, and policy actions are started, altered, stopped, or expanded. After implementation of the initial mitigating and hedging actions, the adaptive policymaking process is suspended until a trigger event occurs. As long as the original policy objectives and constraints remain in place, the responses to a trigger event have a defensive or corrective character – that is, they are adjustments to the basic policy that preserve its benefits or meet outside challenges. Under some circumstances, neither defensive nor corrective actions might be sufficient. In that case, the entire policy might have to be reassessed and substantially changed or even abandoned. If so, however, the next policy deliberations would benefit from the previous experiences. The knowledge gathered in the initial adaptive policymaking process on outcomes, objectives, measures, preferences of stakeholders, etc., would be available and would accelerate the new policymaking process.

Table 1 contains an overview of the key differences between AMP and adaptive policymaking. Master planning considers only demand uncertainties, whereas adaptive policymaking can encompass all uncertainties that are deemed to be of relevance. Given the static nature of AMP, unexpected events are handled in an ad hoc manner. In contrast, adaptive policymaking is prepared for the consequences of unexpected events. A final point of difference is that outcomes of the plan are monitored on an ex-post basis in the case of AMP, whereas adaptive policymaking continually monitors the outcomes. This allows for a more rapid response if opportunities manifest themselves or when a policy appears to be failing.

Table 1: Differences between Airport Master Planning and Adaptive Policymaking

<table>
<thead>
<tr>
<th>AMP</th>
<th>Adaptive Policymaking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only demand uncertainties.</td>
<td>All uncertainties are considered.</td>
</tr>
<tr>
<td>Ad hoc manner.</td>
<td>Continual monitoring.</td>
</tr>
</tbody>
</table>

IV. ILLUSTRATION OF THE ADAPTIVE APPROACH: LONG-TERM PLANNING FOR SCHIPHOL AIRPORT

In the past decennia, the rate of growth in air traffic was twice as large as the growth of the world economy. It is to be expected that as a result of the explosive increase of the world population, economic growth, and globalization, air traffic will continue to grow. Most large airports are located close to economic centers. This situation causes increasing tension between capacity, environment, and safety at and around these airports. So, one challenge for future airport policies is to decrease this tension.

Aviation demand has undergone unprecedented growth since the early 1990s, fuelled by privatization and liberalization of the aviation industry. Schiphol Airport benefited from this growth and evolved into a major hub in Europe. Since 1990, Schiphol invested in expanding its runway system and terminal. Parallel to the increasing number of passengers and flights handled at Schipol, negative external effects also increased, resulting in regulations concerning noise, emissions, and third party risk.

Nowadays, Schiphol’s position as a hub within Europe is under pressure. Schiphol was surpassed by Madrid in 2006 and now ranks as Europe’s fifth largest airport in terms of air transport movements. The merger of Air France and KLM results in the threat that KLM, the hub carrier of Schiphol and responsible for 52% of the scheduled movements, might move a significant portion of its operations to Charles de Gaulle. The other major airports in Europe are planning on expanding their capacity or developing into a dual airport system. Together, this makes the long-term planning of Schiphol both urgent and problematic given the many uncertainties that are present.

A. Step 1: Specification of objectives, constraints, and available policy options

The long-term policy objective for the Dutch national airport Schiphol is to create room for growth within the boundaries set for safety, noise, emissions, and in compliance with good spatial integration with its surroundings [23]. In general, the following three types of policy options can be distinguished to help Schiphol to meet this objective:

- Expand Schiphol, e.g. add runways, make air traffic management more efficient, expand commercial activities at the airport, improve land-side accessibility, etc;
- Move some air transport activities to other airports, e.g., keep hub-related flights at Schiphol, but move origin/destination (O/D) flights (e.g., charters, low cost, business, and cargo-only flights) to other airports;
- Build a new, large airport at a location where there is enough space for increasing air traffic, without environmental and/or safety disadvantages, but with good landside connections (e.g., on an island in the North Sea off the coast of the Netherlands).

The constraints on the policy include costs, spatial restrictions, public acceptance, and accessibility. The definition of success includes a specified growth in capacity (e.g. in terms of passenger movements, aircraft movements, etc.) and that the living conditions improve compared to some reference situation (e.g. amount of noise within an area).

B. Step 2: Basic policy and its conditions for success

A basic policy might be to expand the physical capacity of Schiphol (add a runway). Conditions for success of this basic policy include that:

- existing capacity and noise constraints on Schiphol are not violated;
- there is sufficient funding for investment in runways and related facilities;
- Demand for and supply of air transport develops as expected.
C. Step 3: Vulnerabilities of the basic policy and anticipatory actions

This basic policy is vulnerable in multiple ways, due to the many uncertainties surrounding the long term planning of Schiphol. Table 2 presents some of these vulnerabilities together with possible actions to handle them. A certain vulnerability is that existing noise limits will be violated. A mitigating action for addressing this vulnerability is to implement a noise insulation program, very similar to one of the actions currently being discussed [23].

Table 2: Overview of Vulnerabilities and Actions

With respect to demand and supply conditions for success of the basic policy, Schiphol faces many uncertain vulnerabilities. For example, air transport demand might grow faster than expected (monitoring), these other airports would be ready to handle the non hub essential flights. If demand appears to be growing faster than expected (monitoring), these other airports would be ready to handle the non hub essential flights. On the other hand, demand might also decrease due, for instance, to KLM deciding to move a significant part of its operations to Charles de Gaulle. This would leave Schiphol without its hub carrier, significantly reducing demand, and changing the demand to origin/destination (O/D) demand. Schiphol could prepare for this uncertain vulnerability by making plans for adapting the airport to an O/D airport. Currently, there is an ongoing debate about the future of the hub-and-spoke network structure. Due to open sky agreements and the development of the Boeing 787, long-haul, low-cost, and hub bypassing on intercontinental routes will become plausible. This could translate into a breakdown of the hub-and-spoke network. Schiphol can prepare for this by redesigning its terminals such that a transformation to international O/D traffic and/or a no frills terminals can quickly be achieved.

With respect to the supply side, Schiphol is vulnerable to the capacity developments at other airports in Europe. The major hubs in Europe are all working on expanding their capacity either by adding runways and expanding terminals, or by moving non-hub-essential flights to alternative airports in the region. Schiphol should install a system to monitor these developments closely and, in case of, for instance, a pre-defined loss in market share (trigger), speed up its capacity investments. A second supply-related vulnerability is the variability in the number of flights that can be handled at Schiphol. Under westerly wind conditions, Schiphol’s hourly capacity is almost halved, resulting in flight delays and cancellations. If, due to climate change, these wind conditions would become more frequent (monitoring), Schiphol would no longer be able to guarantee its capacity. Schiphol could respond to this by making land use reservations and plans for a new runway with a west-east orientation. If the westerly winds became more frequent (trigger), this runway could then be built.

D. Step 4: Implementation

In the implementation phase, Schiphol might experience faster growth than anticipated in the plan. The signposts might indicate that Schiphol is maintaining its positions as a mainport; however, the boundaries set for safety, the environment, and quality of life, and spatial integration with its surroundings might be violated. There are now three options: if it is still believed that the policy is the correct one, defensive actions could be taken, for example by explaining to the inhabitants of the area why there is an increase in noise; if there are aspects of the policy that could be improved, taking corrective actions, for example by moving some operations to other airports, would be the logical strategy; however, if conditions are totally different from those anticipated when the policy was developed, the policy should be reassessed and consider a change of our overall goal to maintain a hub airport in the Netherlands. If the latter option is chosen, we would have to reiterate through the adaptive policy making steps in order to develop a new (adaptive) policy.

To illustrate how the monitoring system would operate, a single example for the uncertainty surrounding the air traffic demand. Schiphol would monitor passenger movements and aircraft movements on both a monthly and yearly scale. If over a sustained period of time, the demand would be higher then anticipated, actions would be triggered. If the demand would be slightly higher, the defensive action would be sufficient. If the demand continuous to grow, corrective actions would be necessary. If the demand would be significantly higher, a reassessment of the policy would be needed.

V. Conclusion

The traditional way to treat uncertainty in ASP is through AMP. Based upon a single forecast of future traffic demand, a blueprint for the future of the airport is designed. Since this approach only considers demand uncertainties, most uncertainties are ignored, and the forecasts is almost always wrong. As a result, AMP results in serious negative consequences for the long-term development of an airport, including an inability to implement the plan, severe capacity constraints due to unanticipated regulations, an inability to meet the actual demand, and unnecessary investments in airside and landside facilities.

We have presented an alternative policymaking approach that is especially suited for the treatment of the many uncertainties that airport face. According to this approach, the future is unpredictable. There are an infinite number of possible future worlds and we have no way of knowing which of these futures will manifest itself. Instead of developing a static plan, this approach holds that we should aim at developing plans that allow for change, learning, and adaptation over time based on new knowledge and changing circumstances. As a result, when this approach is used for ASP, in addition to demand uncertainties, many more
uncertainties are considered and reactions are prepared. Based on the fact that adaptive policy making will result in a flexible plan that is designed to accommodate all the relevant uncertainties airport planner face, we conclude that adaptive policymaking is a highly promising alternative to the traditional forecasting-based AMP approach and that its application might prevent future mistakes in airport planning.

REFERENCES


**I. Stage Setting**

- Constraints
- Objectives
- Definitions of Success
- Options Set

**II. Assembling Basic Policy**

- Necessary Conditions for Success
- Policy Actions

**III. Specifying Rest of Policy**

- Vulnerabilities
- Mitigating Actions
- Hedging Actions
- Triggers

**IV. Implementation Phase**

- Other’s Actions
- Unforeseen Events
- Changing Preferences

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**Characteristics**

<table>
<thead>
<tr>
<th>Policymaking Approach</th>
<th>Master Planning</th>
<th>Adaptive Policymaking</th>
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</thead>
<tbody>
<tr>
<td>Treatment of uncertainty</td>
<td>Only demand uncertainties are considered and reduced through demand forecasting; other uncertainties are ignored.</td>
<td>Key uncertainties that can influence the performance of the plan are identified and treated qualitatively.</td>
</tr>
<tr>
<td>Response to unexpected events</td>
<td>Unexpected events are treated in an ad hoc manner.</td>
<td>An adaptive plan contains pre-specified actions (e.g. defensive and corrective actions) that are triggered when unexpected events lead to unwanted outcomes.</td>
</tr>
<tr>
<td>Monitoring of outcomes</td>
<td>Limited monitoring, mainly on an ex-post basis.</td>
<td>Outcomes would be monitored as part of the implementation process. The outcomes to be monitored are based upon the objectives of the policy.</td>
</tr>
</tbody>
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**Vulnerabilities**

<table>
<thead>
<tr>
<th>Certain: Resistance from Schiphol stakeholders (e.g. environmental groups, people living around Schiphol)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mitigating Actions:</strong></td>
</tr>
<tr>
<td>- Develop green areas to compensate for environmental losses</td>
</tr>
<tr>
<td>- Offer financial compensation to residents in the high noise zone</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Certain: reduction of the land side accessibility of the airport</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mitigating Action:</strong></td>
</tr>
<tr>
<td>- Develop a system for early check-in and handling of baggage at rail-stations</td>
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<table>
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<tr>
<th>Demand</th>
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<tbody>
<tr>
<td>Uncertain: Demand for air traffic grows faster than forecast</td>
</tr>
<tr>
<td><strong>Hedging Actions:</strong></td>
</tr>
<tr>
<td>- Prepare to adapt surrounding airports (i.e. Rotterdam and Lelystad) for specific users</td>
</tr>
</tbody>
</table>

**Possible Signposts/Triggers/Actions**

- Monitor the growth of Schiphol in terms of passenger movements, aircraft movements (and related noise and emissions); trigger defensive, corrective, or reassessment actions as needed.
<table>
<thead>
<tr>
<th>Vulnerabilities</th>
<th>Mitigating/Hedging Actions</th>
<th>Possible Signposts/ Triggers/Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>(e.g. all-cargo flights, low-cost price carriers)</td>
<td>Conduct study to determine a location for a new airport that can replace Schiphol</td>
<td>for instance:</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Defensive:</em> Explain increase in noise to residents</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Corrective:</em> Switch O/D flights to other airports</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Reassessment:</em> Begin process of building an airport at the new location</td>
</tr>
<tr>
<td>Uncertain: Collapse or departure of the hub carrier (KLM) from Schiphol</td>
<td>Hedging Action:</td>
<td>If KLM leaves Schiphol, implement the plans to change Schiphol into an O/D airport</td>
</tr>
<tr>
<td></td>
<td>− Prepare to adapt Schiphol to be an O/D airport</td>
<td></td>
</tr>
<tr>
<td>Uncertain: Rise of long haul low cost carriers</td>
<td>Hedging Action:</td>
<td>Monitor development of the business model of low cost carriers. If these evolve into long haul</td>
</tr>
<tr>
<td></td>
<td>− (Re) design terminal to allow for rapid customization to airline whishes</td>
<td>low cost, implement modifications to terminal</td>
</tr>
<tr>
<td>Supply</td>
<td></td>
<td></td>
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<tr>
<td>Uncertain: development of wind conditions due to climate change</td>
<td>Hedging Action:</td>
<td>Monitor the prevailing wind conditions throughout the year, if strong westerly winds become</td>
</tr>
<tr>
<td></td>
<td>− Land use reservation for a runway with east-west orientation</td>
<td>more frequent, a new runway should be developed to guarantee the hourly capacity</td>
</tr>
<tr>
<td>Uncertain: Capacity developments of other major airports in Europe</td>
<td>Hedging Action:</td>
<td>Monitor declared capacity for the major Airports in Europe, if Schiphol is falling behind,</td>
</tr>
<tr>
<td></td>
<td>− Land use reservations for new runway</td>
<td>implement the changes</td>
</tr>
<tr>
<td></td>
<td>− Investments in ATM to expand capacity</td>
<td></td>
</tr>
<tr>
<td>Uncertain: Insufficient funds for investment</td>
<td>Hedging Action:</td>
<td>Monitor financial situation, in case of trigger (insufficient funding) implement corrective</td>
</tr>
<tr>
<td></td>
<td>− Make contacts with potential investors; establish lines of credit</td>
<td>action (e.g. make additional investments)</td>
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