Kansai International Airport

Final Report

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Introduction

Kansai International Airport (KIX), locally known as Kankū (関空) in Japanese, is an expansive international airport located in the bustling Osaka Bay. Kansai acts as a major hub in southeastern Japan, today serving over 23 million passengers per year (Kansai Airports 2017). Specifically, the cities of Kobe, Osaka, and Sakai are the main destinations of travelers landing at Kansai.

Kansai’s distinction as the most expensive airport to be built (projects currently under construction may amount to more) makes it a unique and interesting infrastructure project (Fujita 2015). To date construction costs for the project have totaled around $20 billion dollars (Fujita 2015). This is due in part to its location on an artificial island that was constructed over the span of seven years (1987-1994). At the time of construction, this was notably the first airport constructed on an artificial island, and set the standards for the engineering innovation of airports in highly populated areas (Mesri and Funk 2014). The island is then connected to mainland Japan by a specially designed three-kilometer bridge, which provides rail and car access to Osaka. However, since construction, the airport has been sinking into the ocean at a much faster rate than expected, and has been mired in financial controversy. Because of these factors, Kansai has been debated by engineers, government officials, and consultants alike as one of the most intricate, groundbreaking, and infamous airport projects in the world. The table below shows Kansai’s relative costs compared to other major world airports to provide a better picture of the scope of the cost of the Kansai Project.
The guiding questions for our analysis of the Kansai International Airport project will be the following:

- What factors led to Kansai becoming the most expensive airport ever built?
- Considering quantitative and qualitative costs, would the alternative of expanding Itami Airport have been more successful?

**PROJECT INFORMATION**

In the 1960s, the city of Osaka was losing trade to Tokyo, and the city government was interested in building a new airport to expand air travel capacity and compete as a hub and gateway to Asia. Two alternatives were initially proposed: expanding the already existing Itami airport in downtown Osaka, and creating a new offshore island in Osaka Bay. To avoid the noise pollution and land acquisition disputes and costs that would have resulted if the airport had been built in the dense suburbs of Osaka, the airport was planned for an artificial island in Osaka Bay (Engineering Timelines 2017). A special public corporation, Kansai International Airport Co., Ltd, was jointly formed by the national and local governments and private sector to construct and operate the airport (MLIT Japan 2017).
Construction of the artificial island, which started in 1984, posed numerous engineering challenges, both expected and unexpected. The site was five kilometers from the eastern shore of Osaka Bay, where the water was 18.5 meters deep. The seabed consisted of 20 meters of soft alluvial clay, on top of an additional 400 meters of diluvial clay. In order to form a solid platform for the island, 178 million cubic meters of landfill material were needed. Additionally, a million vertical sand drains were made in the alluvial clay to speed up settling of the material (Engineering Timelines 2017).

![Image 1. Landfill of Kansai in progress](image)

After the island was constructed, development of the actual airport began. The main airport terminal had several notable features, including adjustable columns supporting the terminal building to compensate for subsidence of the island, and sliding joints in the building to protect against seismic damage. These joints were tested in 1995 when Kansai survived the magnitude 6.9 Kobe Earthquake unscathed (ESA 2017). Due to all these added features, at the time of its opening in 1994, Kansai International Airport had cost a record $14 billion, up from its original proposed cost of $6 billion (Sims 2001, Yale 1986).

Numerous difficulties were quick to hit the project. Originally, the airport was predicted to subside 5.7 meters; however, by 2001 the land had already subsided...
11.6 meters (ESA 2017, Sims 2001). $2.21 billion had been spent on repairs by 2001, including building a concrete wall to guard against seawater seepage in the terminal basement. In 2000, Kansai International lost $1.28 billion; this loss was attributed to the cost of repairs, decreasing air traffic, and competition from new airports in Seoul and Hong Kong. At the time, KIX also charged landing fees that were 3.5 times higher than the international average (Sims 2001). By 2008, costs associated with the airport totaled $20 billion, although the rate of subsidence had by then decreased to 7 centimeters per year from 50 centimeters per year in 1994 (ESA 2017).

In early 2015, the government agency running Kansai International sought a private entity to buy the rights to operate KIX and the nearby smaller Osaka airport for a price of $18 billion, as well as take the nearly $10 billion debt associated with KIX (Fujita 2015). In December 2015, the rights for operating the two airports for 44 years were transferred to a consortium led by Japanese leasing giant Orix and Vinci Airports of France for the asking price of $18 billion (Nikkei 2015).

**Motivation and Scope**

Kansai International Airport is an example of an infrastructure project in which decisions were made under significant uncertainties. Possible futures were not fully considered, leading to unanticipated consequences and cost overruns. It is also an example of a project that was initially a public-private partnership, but has recently been transferred to a full private ownership. For these reasons, KIX is a great case study to interpret the practical implications of various concepts we have been studying in 1.011: planning for uncertainty, analyzing alternatives, financial calculation, cost benefit analysis, and public vs. private ownership.

When the Kansai airport plan was finalized in 1984, the initial price tag on the project was estimated to be $6 billion dollars (Yale 1986). As mentioned previously, the final cost of the project in 2008 when all phases were finished
amounted to $20 billion. This report will analyze how these extra costs were occurred and how they impacted the project’s NPV. Also examined are the justification for why Kansai is the most expensive airport in the world, considering factors such as the sinking of the island, additional and unforeseen repair costs, and initial costs from building the main terminal, which at its time was the world’s longest (Engineering Timelines 2017).

Additionally, many assumptions the planning authorities made about the airport when it was designed have turned out drastically different than expected. These assumptions included the old Osaka International Airport closing, more air traffic, and more competition from airlines for landings and gate slots. This report will investigate the scenarios that were initially developed, and the effect of reality being quite different than the expectations that were planned for.

This report will also investigate and understand the reasons behind the sale of Kansai in 2015 and the motivation behind the transition of Kansai from a public-private partnership to a 100% privately owned entity. It will also investigate the decisions of stakeholders on this call and discern what might have pushed the Japanese government to seek a private buyer. This will also help ascertain any effects that the sale has had on the project.
Alternatives/Risks

The first alternative for meeting Osaka’s air transport goals we examine in this report is the expansion of the existing Itami Airport, without the construction of any new airport. We were unable to find original documents evaluating this alternative, so our analysis of this alternative is based on data for a very similar proposal for the expansion of Kai Tak Airport in Hong Kong. Both Itami and Kai Tak were single-runway airports located in downtown areas, and both Osaka and Hong Kong were interested in expanding their air travel capacity via either expansion or a new, more distant airport. Expansion of the existing airport would entail the construction of new runways and terminals for both passenger and cargo traffic, as well as the construction of new highways to expand road traffic capacity between the airport and the city (Government Secretariat Land and Works Branch 1989). To accomplish this, the airport would need to expand into downtown areas that were occupied by various businesses and residents.

Image 2. Itami Airport

The main risk associated with this alternative concerns the difficulty of expanding into the densely populated downtown area of Osaka, as well as the public resistance to continued operation of a major international airport in Osaka. Historically, residents have been opposed to the expansion of Itami: when the
Japanese government used eminent domain to acquire land for an earlier expansion of Itami in 1966, activists and local farmers built and occupied a “solidarity cabin” on the land to block the expansion (Aldrich 2016). There had also been previous community opposition to the operation of Itami Airport: when jet flights began in 1964 at the airport, the resulting noise pollution caused residents near the airport to file a lawsuit in 1969 seeking compensation and a nighttime flight ban. Consequently, the government banned nighttime takeoffs and landings at Itami between 10:30 P.M. and 6:30 A.M. (Tsuru 2000). Considering this well-established and well-organized public opposition, the expansion of Itami to accommodate even greater levels of air traffic would likely be very expensive both financially and politically. Uncertainty in the future operation of Itami is also a significant risk, given the precedent of abutter power to limit airport activity.

Image 3. Density of downtown Osaka and Itami aerial view
The second alternative we examine in this report (and the one which was ultimately chosen) is the construction of a new airport on an artificial island in Osaka Bay. In order to avoid the land acquisition and noise disputes associated with air traffic in the Osaka area discussed earlier, the artificial island in the bay was selected as the best location for the new airport. The airport would be connected to the downtown area via a rail link. One terminal and one runway would be initially built, with the ability to expand by constructing additional landfill in the future. Although this alternative is less conveniently located and less straightforward to construct, it is politically favorable and avoids friction with area residents.

One main risk associated with this alternative is the uncertainty involved with constructing an entirely new artificial island. This proposal was to be one of the earliest airports constructed on an artificial island; consequently, there was limited engineering experience with the construction of large artificial islands. A second main risk associated with this alternative is that revenues from the airport would need to remain reliable in order to offset the high initial cost of construction. These two risks would eventually grow to become significant issues for the project, and will be discussed in more detail in the later section titled “Major Issues”.

A desire to avoid public backlash and conflict was the primary driving factor in the selection of the second alternative over the first. While plans for Kansai Airport were being developed, plans for an airport at Narita near Tokyo resulted in protests by citizens that were at times violent and proved to be very expensive for Narita City – it is notable that “between 1967 and 1976, Narita City spent between a third and a half of its total budget on airport-related expenses” (Aldrich 2016). The example set by these events, in addition to the established opposition to the expansion of Itami discussed above, led planners for Kansai to prioritize citizen groups’ demands. The willingness of planners to acquiesce to locals’ demands can be seen in the distance of the airport from the mainland: the island was “originally
planned to be only 1 km offshore... but fishermen protested, and the airport island was moved an additional 5 km" (Aldrich 2016). In the airport planners' calculus, avoiding political friction was worth the additional costs of building offshore.

*Image 4. Distance of Kansai from Osaka is highlighted*
Stakeholder Analysis

A stakeholder can be defined as a person, group or organization that has interest or concern in a project or organization. Stakeholders can influence or be influenced by a project’s objectives, completion, policies, or timetables. At the end of the day not all stakeholders are created equal, and can affect a project in different ways. To classify and organize the stakeholders that were invested in the Kansai International Airport project, each stakeholder was assigned certain attributes based on the Mitchell framework. These attributes were:

- **Power**: the ability of a stakeholder to impose its will on the development of the system or on other stakeholders, can affect or be affected by the organization’s actions, objectives and policies.
- **Legitimacy**: the generally perceived assumption that a stakeholder has a proper claim within a relationship.
- **Urgency**: a function of both the time-sensitivity of an issue and whether the stakeholder considers the issue to be of vital importance.

For each attribute, if the specific attribute applied to the stakeholder we gave them a score of 1 (i.e if power applied to Osaka residents, they would get a 1-P), and if the attribute did not apply they would get a score of 0. Then stakeholders were categorized by which attributes they were assigned. For example, a stakeholder that had the characteristics of Power and Legitimacy would be defined as a Dominant Stakeholder. In the following sections, we define the breakdown and rationale for classification of all eleven stakeholders we identified as having an investment in the construction of the Kansai Airport project.
Definitive Stakeholders (P, L, U)

Osaka-area Residents

Osaka-area residents are residents living in the city and suburbs of Osaka; this group would have been affected by noise and land acquisition had KIX been built on land. In order to avoid the difficulties posed by these interests and disputes, KIX was eventually built offshore.

Power: 1 - Residents are able to protest, dispute, and reduce public support for the project in order to ensure that their needs and interests are met.
Legitimacy: 1 - Because they live in the area, residents' long-term day-to-day life would be directly impacted by an intrusive air travel hub. As such, they have a valid interest in where the airport is built and how it will operate.
Urgency: 1 - Residents would experience direct and immediate effects to their quality of life if airport is built near where they live; as such, influencing the course of the airport project is an immediate concern.

MLIT

MLIT is the Japanese national government’s Ministry of Land, Infrastructure, Transport and Tourism. It includes the Japan Tourism Agency and the Civil Aviation Bureau and is the largest Japanese ministry. MLIT is responsible for airport development and management, among other national transportation and tourism interests.

Power: 1 - MLIT has the power to initiate airport construction and manage many operational aspects of the airport, including setting landing fees and control tower protocols.
Legitimacy: 1 - MLIT is the primary agency responsible for management of air travel, airports, and other critical infrastructure.
Urgency: 1 - It is the responsibility of MLIT to meet growing demand for air travel and solve over capacity problems; it needs to respond to a need for air travel capacity in the Osaka area in a timely manner.

**LOCAL GOVERNMENT**

Local government refers to the government of the Osaka city and region. This government is interested in competing with Tokyo, the other major hub in Japan, for business and tourism.

- Power: 1 - The local government holds stock options in the Kansai International Airport company, and thus has power regarding the direction of the airport project. It also has legislative power, and can thus influence where and how the airport is built and operated.
- Legitimacy: 1 - Kansai will have a pronounced impact on the local economy, especially in tourism and trade, as well as on factors that impact local quality of life such as traffic and noise.
- Urgency: 1 - The faster the completion of Kansai, the faster the impact on the local economy and quality of life of Osaka residents.

**KANSAI INTERNATIONAL AIRPORT COMPANY (KIAC)**

The Kansai International Airport Company Limited, was a holding corporation founded in October 1984, which planned, organized, and operated Kansai International Airport. The major shareholders of the company included the National Government of Japan, which owned about two thirds of the shares, as well as the local Osaka Government, and various private organizations. This company is an important stakeholder as they were the primary organization in charge of developing the plans for Kansai airport, and were also interested in delivering public service while generating a revenue stream from the project.
Power: 1- As the holding corporation in charge with owning and operating Kansai, KIAC has immense power and influence over the proceedings of the project.

Legitimacy: 1- Again as the owner of the airport, KIAC has a legitimate claim in the construction and success of the project.

Urgency: 1- KIAC has spent years developing plans for the airport and thus are pressing for the project to be finalized and constructed.

**Dominant Stakeholders (P, L, o)**

**National Government**

The Japanese national government would be interested in competing with other countries for business/tourism/trade.

Power: 1- Holds stock options in the Kansai International Airport company, and thus has power regarding the direction of the airport project

Legitimacy: 1- Kansai is meant to be a national aviation hub, easing some of the pressure off Narita and Tokyo, and shall have a sizeable impact on the national economy

Urgency: 0- Narita already serves as an expansive international hub, so no rush in pushing for the completion of Kansai

**Airlines**

Airlines that fly to Kansai include: United, Hawaiian Airlines, Japan Airlines, Delta, ANA, EVA Air, China Southern, Korean Air, China Airlines, Air India, American Airlines, KLM, Finnair, Cathay Pacific, Emirates, Jin Air, Air China, Air France, Jetstar, Asiana Airlines, Singapore Airlines, Xiamen airlines, China Eastern, Air Canada, Sichuan Airlines, Lufthansa, Philippine Airlines, and Thomson Airways.
Airlines are an important stakeholder as they pay fees for landing and using the terminals of the airport, and in some sense, are the airport’s "customers." Some airlines might also be interested in using KIX as a hub for operations.

Power: 1 - Airlines can choose whether to use Kansai, and have complete power over dictating the usage of the airport. They can threaten to fly into the old Osaka airport, or even use Singapore or Incheon as their hubs instead.

Legitimacy: 1 - Airlines provide revenue for the airport and serve as its primary source of cash flows, thus have a lasting effect on the project's success.

Urgency: 0 - While most airlines would benefit from the Kansai project in the sense that they would now have the potential to land more flights, there still is no direct pressing need as they can still use the current existing airports in Osaka and surrounding regions.

Dependent Stakeholders (o, L, U)

**Construction Contractors**

Construction contractors are the companies that were hired to construct the artificial island and terminal upon it for KIX. These contractors would profit from this very large capital project.

Power: 0 - The contractors’ role is to only to carry out the construction of the airport; they have no part in planning or decision-making.

Legitimacy: 1 - Contractors are critical to the realization of the airport, and also play a large role in the local economy. Profit for the contractors would be money going into local workers’ pockets and into the economy.

Urgency: 1 - Contractors would be interested in quickly securing a large source of revenue.
Dangerous Stakeholders (P, o, U)

No dangerous stakeholders identified.

Dormant Stakeholders (P, o, o)

COMPETING AIRPORTS

Large international airports in the Asia Pacific region such as Hong Kong International Airport, Changi International Airport, and Incheon International Airport all contributed to the motivation for the construction of KIX. Additionally, they all were impacted by the success of the Kansai Project as the success of KIX as an international hub would impact air traffic flow to these airports.

Power: 1- Success of other Asian airport hubs (Singapore, South Korea) puts pressure and incentives on building a new airport hub in Japan to compete.
Legitimacy: 0- These airports are not directly invested and have no direct influence on the Kansai project.
Urgency: 0- Not a pressing issue for other airports, in fact they would rather prefer that Kansai doesn’t get built as that would be increased competition.

Discretionary Stakeholders (o, L, o)

LOCAL BUSINESSES

Local businesses include hotels and shops that would be located around the airport, as well as businesses of all types in the Osaka area (both in the city and in the greater region). These businesses would benefit from an increase in local economic activity due to increased tourism and trade from the airport.
Power: 0 - Businesses do not have power over airport planning and decision-making. They are dependent on the economic effects of the airport, not a driving force in its development.

Legitimacy: 1 - Airport construction and success would directly influence the success of local businesses, bringing visitors and economic activity to the area.

Urgency: 0 - The proposed airport is one of many sources of revenue for local businesses; to them, it would be beneficial but not imperative or critical that the airport be built and be successful.

**WEST JAPAN RAILWAY COMPANY**

The West Japan Railway Company is the Japanese railway corporation that oversees operation of the high-speed rail link between Kansai and downtown Osaka. The corporation could benefit from an airport further away from the city of Osaka as they could charge higher ticket prices, but inversely they are also tasked with the construction of the rail line to the island.

Power: 0 - The company wouldn’t have any power over the construction of the rail bridge to the mainland.

Legitimacy: 1 - The company has a direct investment in the success of the project, as it would impact the revenues and costs associated with their owning and operating of the Kansai Airport Line.

Urgency: 0 - It is not critical to the railway company that the airport is constructed as they have a full system of operations from which they can already gain revenues.

**Demanding Stakeholders (0, 0, U)**

No demanding stakeholders identified.
Non-Stakeholders (0, 0, 0)

**Passengers**

Individuals that fly in and out of Kansai Airport would have an additional option for flying into or through Japan. These passengers are important because they drive demand for air travel and airport capacity.

Power: 0 - Passengers have some economic power and can create demand, but are not cohesively organized and do not have significant influence as a unified group.

Legitimacy: 0 - Passengers are not personally invested in this particular airport. They have many other choices for air travel in the region.

Urgency: 0 - Many other options are available to passengers; whether or not this airport is built (and how it ends up) is not very important to most, for whom traveling is just one part of life.

**Interactions Between Key Stakeholders**

Two of the definitive stakeholders (MLIT and the Osaka-area local government) and one of the dominant stakeholders (the Japanese national government) worked together to form the Kansai International Airport Company, which we classified as a definitive stakeholder. The interactions between this stakeholder and Osaka-area residents, another definitive stakeholder, were a primary conflict and driving factor in determining the outcome of the overall project. Ultimately, while both groups had all three of power, legitimacy, and urgency, the residents had more of all three – they were very strongly motivated to protect their quality of life, had a legitimate claim to their interests, and were able to employ tactics such as protesting and occupying land. Consequently, residents’ interests became a main priority for the project, over the Kansai International Airport Company’s interest in keeping expenses low.
Table 2. All mentioned stakeholders are put into a Venn diagram based off the Mitchell Framework. Key stakeholders are highlighted in blue.
Major Issues

One of the major issues faced by the Kansai International Airport project was subsidence of the artificial island at a greater rate than expected. Initially, the island had been predicted to sink 5.7 meters; by 2001, the island had sunk 11.6 meters and was still continuing to settle. It was not until 2008 that the sink rate had decreased significantly, from 50 centimeters per year in 1994 to 7 centimeters per year in 2008 (ESA 2017). This excessive settlement necessitated expensive measures to mitigate negative effects, including a concrete wall in the terminal basement to guard against seawater seepage and control the building’s rate of subsidence. These measures cost $2.21 billion by 2001, and would eventually total $6 billion in expenses (Sims 2001).

This settlement posed a major issue for the project due to both an incomplete understanding of the seabed underlying the construction site, and a lack of contingency planning for unexpected subsidence. The seabed consisted of 20 meters of soft alluvial Holocene clays, followed by approximately 240 meters of less compressible Pleistocene clays. The upper Holocene clay layer was treated before filling by installing one million vertical sand drains, which were designed to accelerate the compaction process. No effort was made to accelerate the compaction of the lower Pleistocene layer due to its depth; instead, an effort was made to predict the settlement as accurately as possible. The vertical drains in the Holocene layer worked successfully, reaching 90% of its total six-meter settlement during the construction period; this settlement had been compensated for in the design through additional fill and seawall height. However, the Pleistocene layer did not behave as predicted: first, there was a large immediate settlement, followed by a slower than expected rate of settlement, then a rate of settlement that did not decrease as much as expected. Attempts to correct models as these changes were observed were made difficult by each new unexpected development; in addition, the design provided no way to add additional fill onto the island by barge as had been done during construction (Puzrin et al. 2010).
A second major issue faced by the project was financial difficulty due to competition for air traffic with the older Itami Airport. The original plan had been to close Itami Airport after the opening of Kansai, and so Kansai was built with enough capacity for the entire region’s air traffic. However, “the old airport is … much more convenient, for both its passengers and workers… their political pressures kept Osaka/Itami open and it is still one of the busiest airports in the world.” Consequently, the new Kansai airport lost regular traffic and was forced to charge high landing fees; in addition, “because the runways at the two airports are almost at right angles to each other, their simultaneous operation complicates flight paths” (de Neufville and Odoni 2003). Planners for Kansai failed to consider the possibility that Itami Airport would not close as planned, and did not incorporate a contingency plan for this scenario into the airport’s design.
Financial Analysis

A financial and cost benefit analysis of a project can be useful to determine whether a project should be carried out or not. This analysis can be used to evaluate the risks and rewards of the project, or alternative plans of the project that are under consideration. Additionally, financial analysis in particular can help paint a clearer yes or no picture to if a project should be completed. When doing a cost benefit analysis, if all potential costs and benefits are properly accounted for, and the benefits outweigh the costs, the project may be the considered investment may be a good choice.

The first step in our cost benefit analysis was to do an NPV financial analysis of the Kansai International Airport project. As discussed earlier, when the airport was being planned there were two main alternatives being proposed. The first was the continued use of the already in place Itami Airport (also known as Osaka International Airport), except expanding and renovating it to be able to handle more air traffic and passengers. The second was the construction of a brand new offshore island airport (what we now know as Kansai). One of the guiding questions we’ve had through this report has been what factors have made Kansai the most expensive airport in the world, and could that title have potentially been avoided? Through an extensive NPV analysis of both the completed Kansai project and the alternative Itami expansion, we will not only get to breakdown the revenues and costs that came with constructing Kansai, but also get to investigate whether the proposed alternative would have financially been a better plan.

The rest of this section will be broken into an explanation of how the NPV of the alternative was calculated, as well as an explanation of all associated revenues and costs. That will be followed with an explanation of how the NPV for the Kansai project was calculated, accompanied with an explanation of all associated revenues and costs (full excel spreadsheet of these calculations will be attached as well). Lastly, there will be a section on non-financial (qualitative) benefits and costs.
associated with the project, culminating with a discussion on how to weigh and analyze both qualitative and quantitative costs and benefits together.

**NPV Itami Expansion**

The Itami expansion alternative called for renovating the existing airport terminal and runway design to accommodate additional passenger and air traffic flow to Osaka. Itami is located close to downtown Osaka so thus many infrastructure and traffic improvements would be needed to be made in the surrounding region. Since there wasn’t any financial information available for this costs of this alternative, we based and modified our calculations off a proposed alternative for expanding Hong Kong’s old international airport (Kai Tak), for which there was an extensive case study done.

Other assumptions made include the following:

- All the air and passenger traffic that has gone to Kansai since its opening in 1995 would actually have all gone to the expanded Itami airport. Thus, all revenues from aero and non-aero related operations of Kansai would transitively be revenues of the expanded Itami airport in this scenario.

- Yearly revenues were quantified as aero and non-aero revenues.
  - Aero revenues include: Landing fees, parking charges, security fees, passenger service facility charge (PSFC), passenger security service charge (PSSC), baggage handling system (BHS) usage fee, passenger boarding bridge (PBB) usage fee, and fueling service revenue.
  - Non-aero revenues include: Direct management revenue (duty free, retail, etc.), building & land rent fees, car parking fees, etc.

- The yearly operating costs for this airport were not available, however the yearly EBITDA margins were. From this we could find an average EBITDA
margin for the years 1995-2016 and from that average EBITDA margin and the yearly revenues which we had calculated, we could solve for each year’s operating costs.

- The growth rate for both number of flights per year as well as number of passengers per year were calculated using yearly data from 2000-2015 for passengers that flew to Kansai, and number of flights to Kansai. For years which data was not available (1995-2000), the average rate of 2000-2015 was used to scale revenues accordingly. For 2000-2015 the yearly growth rate for numbers of flights and numbers of passengers were used to scale aero and non-aero revenues accordingly.
  - Note: growth rates could also be negative, and this was abundant in several years through the history of Kansai. Since we calculated each year’s growth rate from 2000-2015, our calculations are very precise in determining the rise or fall of yearly revenues.

- Depreciation for this project was calculated using an estimate from a current Kansai airport financial press release, and was evaluated using a straight-line method over a period of 20 years.

- The tax rate \( \tau \) was established as 33% after researching Japanese tax codes and from thorough investigation of Japanese tax policy towards corporations.

- The average WACC (weighted average cost of capital) for the aviation industry is 6.34% and this was \( r_d \), the discount rate used in the NPV calculations.

- The money being spent on constructing the expansion of the airport as well as all future maintenance repairs would be counted as non-taxable capital expenditures, as these expenses would qualify as such.
  - A capital expenditure is defined as: money spent by a business or organization on acquiring or maintaining fixed assets, such as land, buildings, and equipment.
• The initial capital expenditure for this project is adjusted from an estimate for the capital expenditure to expand Hong Kong’s old international airport (Kai Tak). Since both airports and expansion projects were of similar style, scale, and cost, the cost estimate for Kai Tak was altered to account for additional Japanese regulations and changes in construction costs.
  o The final value for the initial capital expenditure was $7.269 billion US dollars.
• The maintenance and repair costs were also adjusted from the Hong Kong expansion project in the same manner.
  o These costs were spread over a six-year time period (same as Hong Kong) at a price of $621 million US dollars per year.
• A perpetuity that is calculated using the average growth rate and average discount rate would be placed in the final year of our calculations (2016) to represent all future cash flows from the project.
• The NPV analysis is done in ($ Millions).
  o All costs, revenues, depreciation, etc. have all been converted from yen for your convenience.
  o Legend: $1,000 = $1 Billion USD
• In the NPV analysis \( t = 0 \) is 1994 (the final year of construction), and is the year all initial construction costs are being realized.

The steps to calculate the NPV for this alternative included the following:

1. Summing all revenues and costs per year.
2. Calculating EBITDA (Revenues- Costs)
3. Summing cash flows:
   3.1. Adding EBITDA \( \times (1 - \tau) \)
   3.2. Adding Depreciation \( \times \tau \)
   3.3. Subtracting initial Capital Expenditure
3.4. Subtracting Capital Expenditure from additional construction/repair costs
4. Discounting cash flows using set discount rate
5. Calculating and properly discounting a perpetuity from final year’s cash flow to represent all future cash flows.
6. Summing all discounted cash flows (and perpetuity) to calculate NPV.

All calculations and tables (Exhibits 1-4) are attached below at the end of this document. For your convenience, all excel files will also be attached.

The final NPV for this alternative after all the aforementioned assumptions and steps taken, was **-$4,850.53 million US dollars ($4.85 billion US dollars)**.

*Figure 4. These graphs show the relative costs and revenues associated with the Itami Expansion project*
This section details the other alternative that was proposed during the designing phase of this project, building a new offshore airport called Kansai. This alternative also called for the closing of the old Itami airport once this was finally built in 1994. Since this is the alternative that was eventually chosen and constructed, there is a lot more financial information to work with in order to conduct our NPV analysis.

Assumptions made for this NPV analysis include the following:

- Since we have the benefit of analyzing this project in 2017, we have the knowledge that once Kansai was built and made operational, the old Itami airport never closed down. Thus, we can have a more accurate calculation of all revenues from aero and non-aero related operations of Kansai, since we can associate all passenger and flight traffic as traffic that only goes to Kansai, not Itami from 1994-2016.
  - Initially when this alternative was proposed it was assumed that Itami would close down and all the revenues from Itami today would transitorily be revenues of Kansai airport instead.
- However, since all financial reports since 2011 from the New Kansai Airport Company have been consolidated as including revenues from both Itami and Kansai, we had to calculate what percentage of aero and non-aero revenues were coming only from Kansai (as shown in Exhibit 5)
- Yearly revenues were quantified as aero and non-aero revenues.
  - Aero revenues include: Landing fees, parking charges, security fees, passenger service facility charge (PSFC), passenger security service charge (PSSC), baggage handling system (BHS) usage fee, passenger boarding bridge (PBB) usage fee, and fueling service revenue.
Non-aero revenues include: Direct management revenue (duty free, retail, etc.), building & land rent fees, car parking fees, etc.

- The yearly operating costs for this airport were not available, however the yearly EBITDA margins were. From this we could find an average EBITDA margin for the years 1995-2016 and from that average EBITDA margin and the yearly revenues which we had calculated, we could solve for each year’s operating costs.

- The growth rate for both number of flights per year as well as number of passengers per year were calculated using yearly data from 2000-2015 for passengers that flew to Kansai, and number of flights to Kansai. For years which data was not available (1995-2000), the average rate of 2000-2015 was used to scale revenues accordingly. For 2000-2015 the yearly growth rate for numbers of flights and numbers of passengers were used to scale aero and non-aero revenues accordingly.
  - Note: growth rates could also be negative, and this was abundant in several years through the history of Kansai. Since we calculated each year’s growth rate from 2000-2015, our calculations are very precise in determining the rise or fall of yearly revenues.

- Depreciation for this project was calculated using exact numbers on the balance sheet from a current Kansai airport financial press release, and was evaluated using a straight-line method over a period of 20 years.

- The tax rate $\tau$ was established as 33% after researching Japanese tax codes and from thorough investigation of Japanese tax policy towards corporations.

- The average WACC (weighted average cost of capital) for the aviation industry is 6.34% and this was $r_{d}$, the discount rate used in the NPV calculations.
The money being spent on constructing the expansion of the airport as well as all future maintenance repairs would be counted as non-taxable capital expenditures, as these expenses would qualify as such.

- A capital expenditure is defined as: money spent by a business or organization on acquiring or maintaining fixed assets, such as land, buildings, and equipment.

- The initial capital expenditure for this project was found to be $14 billion dollars.

- The maintenance and repair costs were an additional $6 billion split over a period of eight years.

- A perpetuity that is calculated using the average growth rate and average discount rate would be placed in the final year of our calculations (2016) to represent all future cash flows from the project.

- The NPV analysis is done in ($ Millions).
  - All costs, revenues, depreciation, etc. have all been converted from yen for your convenience.
  - Legend: $1,000 = $1 Billion USD

- In the NPV analysis \( t = 0 \) is 1994 (the final year of construction), and is the year all initial construction costs are being realized.

- Kansai also received heavy government subsidies until 2012 when the New Kansai Airport corporation was formed. We thought it would be interesting to see how these subsidies affected the NPV of the project (assuming they were untaxed) and provided an NPV analysis of this situation (Exhibit 9).

- Since Kansai was sold to a private consortium of companies in 2016, we also thought it would be interesting to use the sale price to see if even after the sale what the NPV of the Kansai project would be (with and without government subsidies). This is shown in Exhibit 10.

The steps to calculate the NPV for this alternative included the following:
1. Summing all revenues and costs per year.
2. Calculating EBITDA (Revenues - Costs)
3. Summing cash flows:
   a. Adding EBITDA \times (1 - \tau)
   b. Adding Depreciation \times \tau
   c. Subtracting initial Capital Expenditure
   d. Subtracting Capital Expenditure from additional construction/repair costs
4. Discounting cash flows using set discount rate
5. Calculating and properly discounting a perpetuity from final year’s cash flow to represent all future cash flows.
6. Summing all discounted cash flows (and perpetuity) to calculate NPV.

All calculations and tables (Exhibits 5-10) are attached below at the end of this document. For your convenience, all excel files will also be attached.

The final NPV for this alternative after all the aforementioned assumptions and steps taken, without government subsidies was -$15,328.46 million US dollars (-$15.33 billion US dollars).

The final NPV for this alternative after all the aforementioned assumptions and steps taken, with government subsidies was -$12,661.80 million US dollars (-$12.66 billion US dollars).

The NPV after sale for this alternative after all the aforementioned assumptions and steps taken, without government subsidies was -$9,638.67 million US dollars (-$9.64 billion US dollars).

The NPV after sale, including government subsidies for this alternative after all the aforementioned assumptions and steps taken, without government subsidies was -$6,972.01 million US dollars (-$6.97 billion US dollars).
Figure 5. These graphs show the relative costs and revenues associated with the Kansai Airport project.

Discussion of Qualitative Costs and Benefits

The following are qualitative costs and benefits and potential ways to measure them.
• Quality of life of nearby residents: How have residents’ daily lives been impacted by the operation of KIX? Has KIX been beneficial or detrimental to their quality of life? How do residents feel about their airport?
  o Ways to measure: value of homes in area, noise levels, reports of disruption due to airport.
• Environmental impact on Osaka Bay: How has the construction of a large artificial island changed the environment and ecosystem of Osaka Bay? For example, have habitats been destroyed or water chemistry changed?
  o Ways to measure: look at ecological studies of Osaka Bay.
• City/regional image: How has KIX (both considering its role as a major hub and its being infamous for subsidence problems) affected the image of the Osaka area? Is the Osaka area more positively perceived due to the existence of the airport, or is it viewed more negatively?
  o Ways to measure: Consider if news articles and other media involving KIX also show some kind of perception of Osaka (i.e. does the writer seem to view Osaka in a positive, neutral, or negative light?); measure tourism traffic over time (but hard to isolate effects due to KIX)
• Passenger experience: How has KIX over time (from construction up to present operation under private ownership) affected the experience of passengers flying to, from, or through the region? Is flying through KIX a pleasant experience or a difficult ordeal? Did the construction of KIX spurred competition with other airports, improving the experience of all passengers in the region?
  o Ways to measure: Look for reviews, social media posts, and other commentary by passengers flying through Osaka; examine how KIX changed airports in East Asia (e.g. did it lead to the construction of Seoul's and Hong Kong’s airports, and are those airports pleasant to
use due to competition?). Might be difficult to isolate effects due to KIX.

Discussion of Project Success

After quite an extensive financial and economic analysis of Kansai, one which examined all possible costs and revenues, we are left with a few questions.

1. Where did the financing come from?

Most of the money that went into the construction of Kansai (the $14 billion capital expenditure that was seen in the NPV of Kansai), came from the raising of private and public funds. The Japanese national government was the largest contributor, responsible for about 80% of the funding of the project.

2. Was this project “successful”?

After looking at the NPV of Kansai, all qualitative benefits aside, it is very hard to justify a project with an NPV (without government subsidies) of -$15,328.46 million US dollars (-$15.33 billion US dollars). From a purely financial perspective, it would have made more sense to go with the other alternative of expanding Itami, as that was far less NPV negative, and if Itami would have eventually gotten sold to a private consortium like Kansai did, then the project actually could have been NPV positive (assuming the same sale price it would have had an NPV of $859 million USD).

3. Why would a consortium choose to buy Kansai now?

If you are looking at this project from the perspective of a private organization, analyzing Kansai in 2016/2017 all the previous expenditures are a sunk cost, and frankly not your problem. Assuming Kansai doesn’t have exorbitantly high
maintenance costs moving forward (i.e. the island stops sinking so quickly), the project will be quite NPV positive from 2017 onwards.
Project Critique

Our major guiding questions in this report were a) why Kansai became so expensive, and b) whether the alternative of expanding Itami would have been more successful. In summary, we found that the cost of Kansai can be largely attributed to the high initial cost of building offshore, as well as the unexpected costs associated with mitigating island subsidence and loss of revenues to Itami Airport. Our financial analysis showed that the alternative of expanding Itami instead of building Kansai would have been much more successful from a financial point of view; however, the conclusion is less simple to draw when more qualitative considerations (namely, the impact on quality of life of residents and the political resistance to expansion of the airport) are taken into account. In fact, one could argue that given the strong political opposition to expansion of Itami, that alternative might have been impossible (or at least very difficult) to execute.

One major point of criticism we have for this project is that uncertainties and risks in the project were not adequately planned for and managed. No effective contingency plans were developed for the two major risks we identified for this project (land settlement and need for steady revenue), and consequently no easy or inexpensive response was possible when the island subsided or when Itami remained open. Such contingency plans would not have been prohibitively difficult to develop (e.g. a way to add additional landfill during construction to compensate for excessive settlement, or a more incremental increase in airport capacity to gauge demand), and would have been less expensive to implement in the long run. It also appears that cost projections and timelines for the airport did not include sufficient buffers for cost and time overruns due to complications; as a result, the project received much negative publicity for how much it went over budget and past schedule. We speculate that the already very high initial cost projection of $14 billion
discouraged planners from building in large buffers, in the interest of keeping an already high price tag from becoming even less appealing to stakeholders.

A second point of criticism we have for this project is that local residents and citizen groups had a powerful role in determining the outcome of this project, to the detriment of the other stakeholders (MLIT, local and national governments). Not only were residents able to force the new airport to be built offshore, but they were also able to later keep Itami open. Some miscommunication is apparent in this chain of events; in trying to satisfy residents’ concerns about pollution and safety risks, city planners sought to completely remove the airport from the downtown area, but residents actually wanted to keep the existing airport for economic reasons – they just did not want the construction of a larger airport. The major issues faced by the airport can be partly attributed to the uncertainty and changes of plan caused by residents’ demands. While opposition to the expansion of Itami was very powerful, we wonder if the government and airport authorities could have pushed back harder against the influence of citizens and found a better compromise that was not so financially harmful to the airport. In particular, we speculate that forcing the closure of Itami likely would not have had serious long term effects for the city, and would have ensured a more reliable revenue stream for the airport.

In summary, our opinion is that building offshore in order to avoid political resistance was an expensive, but justifiable decision. However, the risks that accompanied this decision were not well managed or planned for, leading to cost overruns and complications that might have been avoided. In addition, a less flexible government/airport position in regards to disputes with residents might have resulted in compromises that were less detrimental to the airport project.
Takeaways and Impact

As the first large airport to be built on artificial land, many of the geotechnical lessons learned from Kansai were applied in constructing later successful airports on artificial islands, including the nearby Kobe, Chubu Centrair International, and New Kitakyushu airports, as well as Hong Kong International Airport (ESA 2017). The geotechnical engineering textbook *Geomechanics of Failures* by Puzrin et al. describes in detail key findings from the Kansai project that can be applied to future projects, including the impossibility of accurate predictions from site investigations alone, the importance of secondary compression in addition to primary consolidation processes, and the necessity of leaving project designs flexible to accommodate observed changes during construction (2010).

The inefficiencies caused by the simultaneous operation of Itami Airport and Kansai International Airport also offered lessons to be learned in the management of multi-airport systems. In a 1995 paper, de Neufville proposed a development strategy for multi-airport systems that emphasizes plans that are “strategic, making investments that insure the future, incremental, phasing modest investments according to proven opportunities, and flexible, providing the insurance to adjust to adjust easily to future situations.” De Neufville cites Kansai/Itami as one example of a multi-airport system in which planners failed to correctly predict traffic patterns and consequently over-invested in the second airport.
Current Status

Today Kansai Airport is under the operation of Kansai Airports Ltd., a company owned and operated by a consortium of private buyers. In its first year of private ownership (fiscal year 2015-2016) Kansai saw its revenues increase for the first time this decade a 2.9% increase on a like-for-like basis from fiscal year 2014-2015. Additionally, the number of passengers to fly through Kansai reached a record high, spurred by a surge in international foreign passengers to the Osaka region.

Kansai Airports Ltd., through the operation of Kansai plans to “attract more traffic through our airports by maximizing the customer experience, and strive(s) to play a significant and increasing role in the local economy”.

*Image 5. Kansai and Itami today in the marketing materials of Kansai Airports ltd.*
Bibliography


“Incorporation of Kansai Airports Revenue and Profits Increase in First Fiscal Year (Dec 2015 – September 2016).” (2016).


## Appendix

### Table 1

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### Notes
- Monthly sales data provided.
- Yearly cost analysis included.
- Profit calculations shown for each year.
Table 2