Maximizing Use of Airport Operations Data: Honolulu International Airport

PANOS D. PREVEDOUROS AND COSTANTINOS S. PAPACOSTAS

Tapping existing data sources that often are scattered among components of the same organization and incrementally enhancing existing data bases and data collection practices within realistic constraints compose a prudent approach to improvement. A recent effort to maximize the use of existing operations data at the Honolulu International Airport is described, and the wealth of analytical capabilities that can be unleashed by taking advantage of routinely collected data that had been used minimally in the past is displayed. Analysis procedures and sample output are given for passenger flow, cargo and mail traffic, flight arrivals and departures, diurnal distribution of operations, load factors, aircraft types, arrival and departure delays, aircraft ground time, and aircraft returns due to mechanical problems. An innovative way to profile airline operations is also presented.

The availability of comprehensive, consistent, accurate, and accessible data is a prerequisite to high-quality analyses and performance evaluations of transportation facilities to support informed policies. But, as several studies have shown (*1–6*), no data base can meet this ideal to the satisfaction of all its potential users. No data base can satisfy all users for many reasons, particularly because of resource and technological limitations, institutional barriers, and constantly changing conditions and requirements. Nevertheless, developments in computer technology and data management methods offer opportunities for significant improvements. Tapping existing data sources that often are scattered within the same organization and incrementally enhancing existing data bases and data collection practices within realistic constraints compose a prudent approach to improvement.

Passenger travel to and from Hawaii depends almost exclusively on the air transportation system. The same is true for travel between the islands that make up the state. It is not mere coincidence that the arrival of the first jet carrier in 1959 marked the beginning of unparalleled economic growth that transformed the state's economy from agriculture to tourism. The now mature visitor industry faces severe global competition, and its success depends partly on the efficiency of the state's airports.

Hawaii's airport system is unique in that the state government owns and operates all public airports on each of the major islands. Located on the island of Oahu, which has 80 percent of the state's population, Honolulu International Airport (HIA) "is the major aviation gateway for the State of Hawaii. It is presently the only airport in the State accommodating international flights, and is the primary hub for overseas domestic and interisland flights" (*7*). Its facilities accommodate all types of aircraft operations, including commuter/air taxi, general aviation, and military flights. Depending on the indicator used (e.g., annual aircraft operations, passenger demand), HIA has been ranked in recent years as the 12th to 15th busiest airport in the country.

Department of Civil Engineering, University of Hawaii at Manoa, 2540 Dole Street, Suite 383, Honolulu, Hawaii 96822.

Responsibilities for operating and directing the statewide system are centralized at the Airports Division of the Hawaii Department of Transportation (DOT). The administration of the division recognizes the importance of the airport system to the state's economy and is fully aware of the central role that high-quality data play in the system's performance. As a result, the division has enhanced its information base and its analytical capabilities. It recently implemented an innovative computer-administered method to conduct airport-user satisfaction surveys and investigated the comparability of the data obtained via this method with those data obtained using traditional techniques (*8*). The division also expressed interest in regularly compiling detailed statistical reports of the aircraft operations and passenger flows handled by the airports under its control. Toward this end, it awarded the authors a project to identify the major sources of data collected within the division, computerize hard-copy information, perform a basic analysis of the data, and undertake further analyses made possible through the integrated data sets obtained (*9*).

DATA SOURCES AND NEEDS

The major types of data that are maintained by various units of the division, current uses of the data, perceived limitations, and expressed staff desires for better data use were identified. Two major and several supplementary data sources were identified, evaluated, and used.

The major long-standing source of passenger, cargo, and mail flows handled at the six major state-owned airports is a monthly air traffic summary submitted by each airline to the division and to the Hawaii Visitors Bureau (HVB), an organization charged with promoting tourism. Designed jointly by the airlines and these two organizations, the report form contains monthly summaries showing the volumes of enplaning and deplaning passengers and the amounts of cargo and mail transported between the major state airports and eight regions of the world. The division processes the hard-copy reports to produce monthly, quarterly, and annual reports for each airport. These data go back to 1960, with 5-year summaries before 1970 and annual reports thereafter. Although conversion from manual to computer-based spreadsheet procedures has improved reporting efficiency, airport staff expressed a need to enhance the tabular format of the reports and to incorporate graphics to aid understanding and interpretation of trends over time.

The major source of disaggregate aircraft flow data was the terminal ramp control tower. These data primarily are used for real-time operations, such as the assignment of gates and baggage claim areas, and displaying and disseminating schedule information to the public. Although the direct need for this voluminous information is transitory, permanent records of otherwise unavailable data are produced in the process on hard-copy logs. The recorded information for each arriving flight includes the date; airline and flight number; an abbreviated form of the aircraft tag number; turnaround flight; aircraft type; origin of flight segment ending at HIA; scheduled, estimated, and actual times of arrival; and assigned/used gate. Similar data are recorded for each departing flight.

For arrivals, the turnaround flight designates the departing flight to which the arriving aircraft is assigned, whereas for departures it represents the arriving flight served by the departing aircraft. The two turnaround flights can be linked to provide information on aircraft use, flight characteristics (e.g., originating at HIA, terminating at HIA, or continuing), and gate use. The size of this data base and the hard-copy format in which it is maintained are two barriers to routine use of the ramp control data for purposes other than real-time scheduling. At HIA the resulting computer file for each month approaches the limits of common spreadsheet programs running on 386-based personal computers. As for the storage medium, hard-copy forms with preprinted information on scheduled operations are computer-generated daily. Entries in the remaining fields (e.g., aircraft, actual time of arrival) and information on unscheduled flights are entered manually on the logs as the day progresses.

Supplementary data sources include confidential monthly landing use charge listings, which are maintained by the Fiscal Office and classified by airline and by airport, and the recently computerized U.S. Customs and Immigration data for each arriving international flight. These data are the only source that provide a breakdown of the characteristics of all arriving passengers on each flight. The categories employed obviously are relevant to the differing processing requirements and related facility needs for citizens and noncitizens entering the country.

DATA PROCESSING, ANALYSIS, AND REPORTING

The data from the previous sources were used, either singly or combined, to compile many statistical reports relating to airports, airlines, and the overall airport system. The integrated data sets were processed further using SPSS/PC+ to quantify a variety of performance indicators and to analyze their changes over time. The main data sets used included the monthly air traffic summaries dating back to 1960 and the disaggregate ramp control data for each January from 1989 through 1992. The confidentiality of the supplementary data was protected by avoiding direct detailed reporting and by embedding only aggregated subsets in composite indicators.

The following sections illustrate both the types of analyses employed and the wealth of useful information that can be obtained by integrating a small number of already existing data sets.

Traffic Flows

The most disaggregate level to which volumes of passengers and cargo could be reported consisted of monthly enplaning and deplaning volumes, by airline and by points of interchange—that is, between individual airports within the state at one end and several subregions of the world at the other. In land-based terminology, the reported interchanges represent unlinked trips, not trips between ultimate origins and ultimate destinations. Nonetheless, the availability of this type of information in automated form can provide quick answers to many policy- and operations-related questions that would be very difficult and expensive to obtain otherwise in a timely fashion. Moreover, because a centralized data base is maintained, aggregating passenger, cargo, and mail flows up to the statewide level and for any period over a month is relatively easy.

Figure 1 presents all annual aircraft operations at HIA by type, that is, air carrier, air taxi, general aviation, and military. This information is subject to further interpretation and association with underlying causes and trends (e.g., increased military carrier activity during the Vietnam War era and declines in civil aviation during downturns in the national economy). Combined with other data, such as passenger flows by sector, the data in the graph reflect changes in technology (i.e., the introduction of larger aircraft) and other factors.

Flight Arrivals and Departures

The segment origins and destinations of overseas flights to HIA are presented in Table 1, which reveals the interchange patterns for cities with four or more monthly flights. A fairly strong diagonal element is observed, which reflects round trips. Two easily distinguishable columns and rows correspond to Los Angeles and San Francisco as origins and destinations of flights. Similar charts were developed for each of the airlines that provide service to Hawaii; these charts clearly demonstrate the dominance of United Airlines in the overseas Hawaiian market.

The pattern shown does not reflect the ultimate origins of arriving passengers or aircraft, particularly those on domestic flights, largely because of the hub-and-spoke networks that evolved in the United States following the Airline Deregulation Act of 1978. Thus, travelers from the East Coast of the United States are likely to be

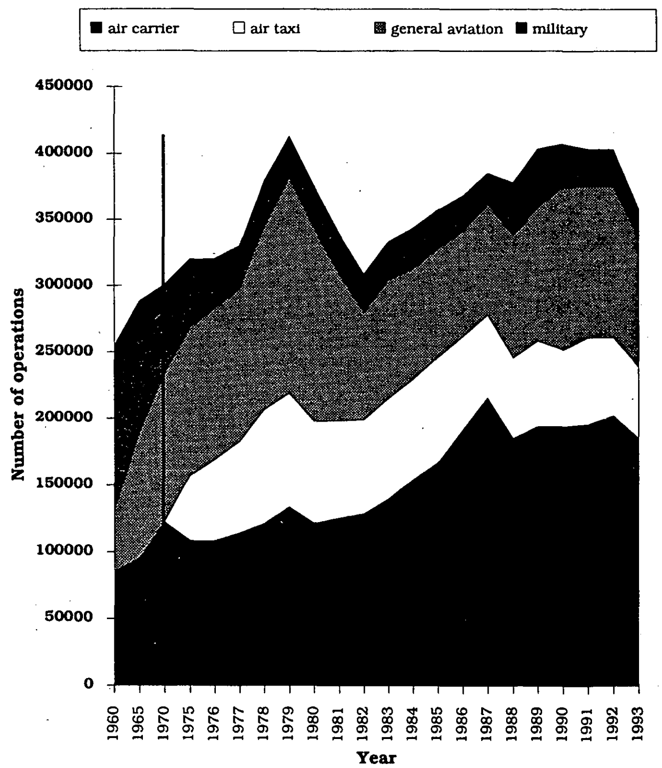


FIGURE 1 Operations by type at HIA.

TABLE 1 Origins and Destinations of Flights to and from HIA (averages from each January from 1989 to 1992)

ORIGIN \ DESTINATION	ATLANTA	AUKLAND	BALI	BIAK	CAIRNS	CHICAGO	DALLAS	DENVER	FUKUOKA	GUAM	HONG KONG	KAHULUI	KONA KEAHOLE	KUALA LUMPUR	LAS VEGAS	LIHUE	LOS ANGELES
ATLANTA	9						13										
AUKLAND		6					4										33
BALI																	9
BIAK																	8
CAIRNS																	4
CALGARY																	
CHICAGO						41		5				22					4
DALLAS F.W.	14	4				4	24					28					12
DENVER								10				8					8
EDMONTON																	
FUKUOKA																	7
GUAM										34							15
HOUSTON																	
KAHULUI						30	29					18					95
KONA-KEAHOLE						7											21
KUALA LUMPUR																	4
LAS VEGAS																	
LIHUE																	
LOS ANGELES		42	9	8	5	11	14		7	19		88	27	4		4	194
MANILA																	24
MINNEAPOLIS																	
NAGOYA																	
NANDI, FIJI																	23
NEW YORK																	
OAKLAND																	
ONTARIO, CA																	
OSAKA																	
PAGO PAGO																	
PHOENIX															8		
SAN DIEGO																	29
SAN FRANCISCO		17				7		10			10	11				26	85
SAN JOSE																	
SEATTLE/TAK.																	8
SEOUL																	18
ST. LOUIS																	
SYDNEY							7										17
TAIPEI																	18
TOKYO																	21
TRAVIS AFB										8							
VANCOUVER		6			6												

ORIGIN \ DESTINATION	MANILA	MINNEAPOLIS	NAGOYA	NANDI FIJI	NEW YORK	OAKLAND	ONTARIO	OSAKA	PAPEETE	PHOENIX	SAN DIEGO	SAN FRANCISCO	SAN JOSE	SEATTLE	SEOUL	ST. LOUIS	SYDNEY	TAIPEI	TOKYO	TRAVIS AFB	TORONTO	VANCOUVER
ATLANTA																						
AUKLAND												10							15			7
BALI																						
BIAK																						
CAIRNS																						
CALGARY																						8
CHICAGO												5										
DALLAS F.W.																	7					
DENVER												5										
EDMONTON																						4
FUKUOKA																						
GUAM												6								6		
HOUSTON																			7			
KAHULUI											5	12										
KONA-KEAHOLE																						
KUALA LUMPUR																						
LAS VEGAS										7												
LIHUE												28										
LOS ANGELES	31			44							25	74		11	17		15	26	16			
MANILA												24										
MINNEAPOLIS		5																				
NAGOYA			14							4									11			
NANDI, FIJI																						5
NEW YORK															6							
OAKLAND						23																
ONTARIO, CA							38															
OSAKA								26				6							66			
PAGO PAGO									4													
PHOENIX			4							16												
SAN DIEGO																						
SAN FRANCISCO	20											134		6			32		10			
SAN JOSE													5									
SEATTLE/TAK.												5		72								
SEOUL					5										31				7			
ST. LOUIS																30						
SYDNEY												30									8	
TAIPEI																						
TOKYO			12					68				17			6				239			
TRAVIS AFB																						
VANCOUVER				8																		51

consolidated at major airports such as Chicago, Denver, Los Angeles, and San Francisco and then flown to Hawaii. Similar patterns apply to several Asian countries. For example, there are no direct flights from the People's Republic of China to Honolulu, and most flights by China Airlines are routed through Tokyo. Complementary sources of data that can supply partial answers to this pattern include the International Air Transport Association's origin-destination passenger and freight statistics, the Air Transport Association's annual survey of airline passengers, and the *Passenger Origination and Destination Survey*, which is based on a 10 percent sampling of airline tickets and filed by certificated U.S. carriers providing scheduled service. For westbound (i.e., from North and South America) visitors to Hawaii, a voluntary survey is distributed by HVB to all passengers on inbound flights.

Diurnal Distribution of Operations

Figure 2 shows the pattern of the average number of daily aircraft operations by time of day for a selected month. This profile includes data for major and regional air carriers only; the data are disaggregated into overseas arrivals, overseas departures, and total operations by each of the two main inter-island carriers. The differences in the profiles of overseas arrivals and departures are influenced partly by the long distances and time differences between Hawaii and the other end of the flights included in the graph as well as by restrictions and curfews imposed at other airports. As demonstrated later in this paper, the operations profiles of individual airlines can be shown separately.

Load Factors

Given the readily available data, approximations of aircraft load factors were possible only for international flights that are unlikely to carry transit passengers (screened from the ramp control data set) and for which flight-specific passenger data are available from U.S. Customs and Immigration. The types of aircraft used for the selected flights also were identified from the ramp control data, but the exact seating configuration of each aircraft was not known; approximate seating capacities were obtained from the *Official Airline Guide*. Analysis of the estimated load factors (Figure 3) by geographic region and airline reveals that airlines from Japan, Korea, and China achieve a high average load factor (weighted by the total number of flights), 75 percent, as do most U.S. airlines, 79 percent. Airlines from Canada display a large load factor variation, with an average of 63 percent, whereas airlines from other Pacific Ocean countries show the lowest average, 41 percent. A possible explanation of the last finding is that these airlines may be flying combined passenger/cargo aircraft with much lower seating capacity.

An interesting, if not unexpected, finding is the trend in the average number of passengers per aircraft over time. The number of pas-

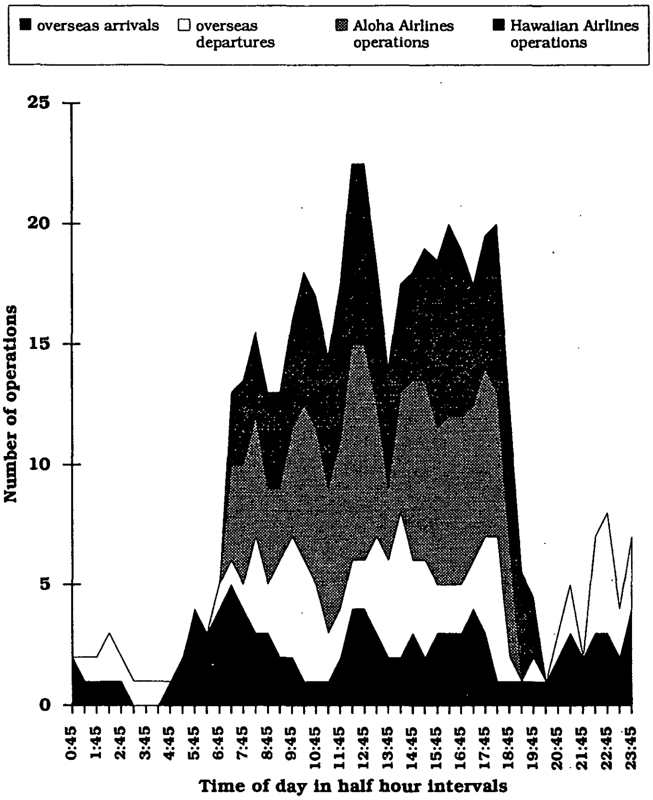


FIGURE 2 Average daily operations in January 1991 at HIA.

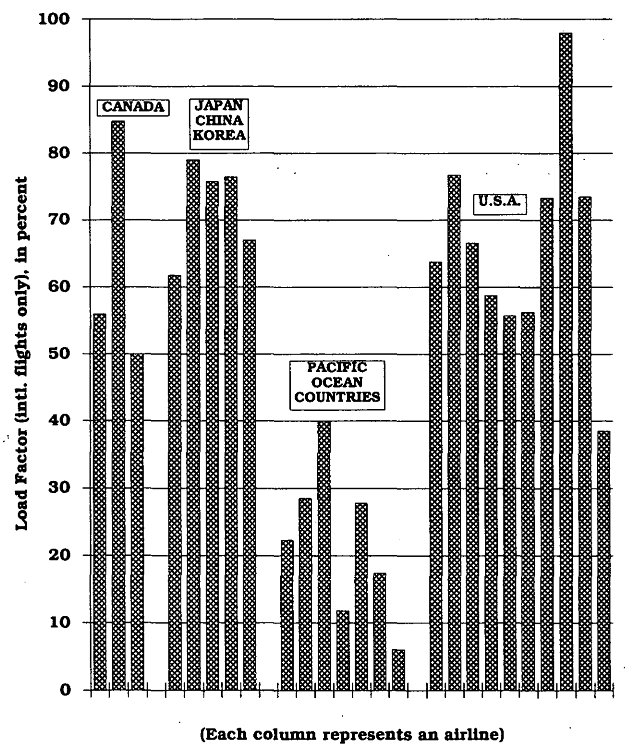


FIGURE 3 Airline load factors.

sengers per aircraft showed a sharp reversal, steadily increasing since the passage of the Airline Deregulation Act of 1978. This finding supports the contention of those who argue that market competition following deregulation has resulted in increased economic efficiencies.

Aircraft Types

Figure 4 presents the 4-year trends in the types of aircraft used by overseas carriers. The B747 and the DC-10 are the overwhelming favorites. However, a mild decline in the share of jumbo-class aircraft and a concomitant increase in the share of large but more economical two-engine aircraft (such as the B767) are also evident. The response of the air carriers to the peak demand experienced during 1990 is also apparent: there was a noticeable reduction in flights using the DC-10, which has approximately 275 seats, in favor of the B747, which has approximately 350 seats.

Arrival and Departure Delays and Aircraft Ground Time

Arrival and departure delays are defined herein as the differences between actual and scheduled operations. This definition is consistent with the manner in which the term is defined in the U.S. DOT's *Air Travel Consumer Report*. As explained, "although these data are useful to consumers insofar as they encourage carriers to publish realistic schedules, they do not provide an accurate gauge of delays because carriers have built many of these delays into their schedules" (*4*). The monthly *Air Travel Consumer Report* contains on-time performance data on domestic flights delayed more than 15

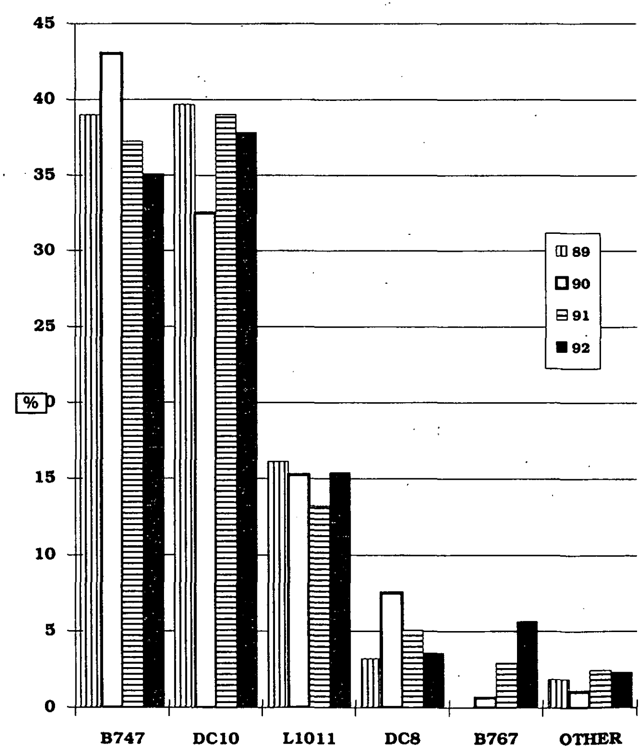
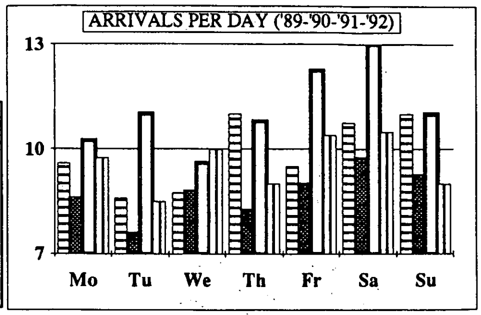


FIGURE 4 Share of aircraft types (overseas arrivals).

PACIFIC AIRWAYS

NOTE: ALL DATA ARE MONTHLY UNLESS OTHERWISE SPECIFIED

NUMBER OF FLIGHTS FROM LISTED CITIES/PLACES				
ORIGINS	'89	'90	'91	'92
LOS ANGELES	93	88	88	65
SAN FRANCISCO	59	60	54	54
GUAM	30	27	35	50
HOUSTON	0	0	30	0
SYDNEY	32	31	30	31
AUCKLAND, NZ	28	30	29	31
TOKYO	1	0	28	31
MANILA	9	8	14	0



VOLUMES	'89	'90	'91	'92
O/S H.I.A./TR	136,187	130,499	141,485	122,387
O/S to N/I	0	0	0	0
I/I PASS.	0	0	0	0
O/S CARGO	8,202,112	7,594,304	9,443,251	8,513,866
O/S to N/I	0	0	0	0
I/I CARGO	0	0	0	0
O/S MAIL	213,082	392,920	1,414,941	1,289,998
O/S to N/I	0	0	0	0
I/I MAIL	0	0	0	0
LAND. FEES	$98,167	$92,558	$115,138	$93,214

Note: O/S/=overseas, TR=transit, I/I=interisland, N/I=neighbor islands]

HIA MARKET SHARES (%)				
O/S PASSENGERS	'89	'90	'91	'92
IN+OUT+TRANSIT	10.9	10.5	11.0	10.2
I/I PASSENGERS	0.0	0.0	0.0	0.0
O/S CARGO	18.8	18.3	20.4	19.2
I/I CARGO	0.0	0.0	0.0	0.0
O/S MAIL	4.7	7.5	24.8	19.7
I/I MAIL	0.0	0.0	0.0	0.0

STATEWIDE MARKET SHARES (%)				
PASSENGERS	6.6	6.3	7.2	6.1
CARGO	14.2	13.5	16.4	13.6
MAIL	3.5	5.6	18.5	15.1
LANDING FEES	8.1	7.6	9.4	6.9

ON TIME PERFORMANCE				
[minutes of delay]	'89	'90	'91	'92
ARRIVAL	2.7	3.2	1.9	8.7
DEPARTURE	16.4	22.0	22.3	4.6

ARRIVALS	'89	'90	'91	'92
(flights/mo)	302	270	342	298

		ARRIVALS	SEATS*
AIRCRAFT ('91)	DC-10	177	296
(*=approximation)	B747	165	353

LOAD FACTOR : 63.9%

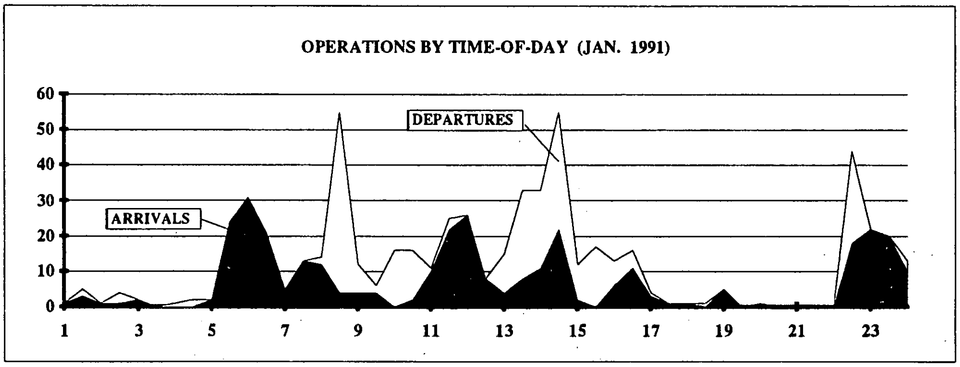


FIGURE 5 Sample airline profile.

min, as reported by the 12 largest air carriers. An alternative definition of delay is used by FAA in two systems: the Air Traffic Operations System, which contains reports submitted by air traffic controllers relative to the total flights delayed more than 15 min, and the Standardized Delay Reporting System, which, since Eastern Airline's demise in 1991, is drawn from reports submitted by two major carriers. The alternative definition of delay is measured against "optimal" rather than scheduled times.

The distribution of arrival delays was compiled from the HIA ramp control data set, which has 10,703 cases for which the actual arrival and departure times of individual aircraft are available. From the 4 months analyzed, 4.6 percent of the flights arrived more than 15 min earlier than scheduled, 86.7 percent arrived within 15 min of the scheduled arrival times, and only 8.7 percent were delayed more than 15 min. A similar analysis revealed that about 10 percent of the aircraft stay in Honolulu for 1 hr or less, 47 percent for up to 2 hr, 19 percent for 3 to 5 hr, and 24 percent for more than 5 hr.

Mechanical Problems

Ramp control data indicate that older aircraft, such as the DC-8, experience by far the highest number of returns. All other major types of aircraft flown to Honolulu have excellent records, given that fewer than 0.5 percent of the departed flights return because of equipment problems. The B747 has improved from 1989 to 1992, whereas the opposite is true for the DC-10. The reason may be related to the age of the aircraft. The B747 is still being produced in large numbers, which means that several aircraft serving Honolulu are fairly new. In contrast, production of the DC-10 has been phased out, and the airplane has been replaced by the MD-11.

Airline Profiles

Integration of the data sets permitted the creation of two-page profiles for each of the 25 air carriers serving HIA. The first page of these summaries (Figure 5) presents the following characteristics:

- Origins of flight segments ending in Honolulu;
- Overseas, inter-island, and in-transit volumes of passengers, cargo, and mail;
- Average monthly number of arrivals;
- HIA and statewide market shares;
- On-time performance;
- Types of aircraft used and average load factors; and
- Average number of arrivals and departures by time of day.

The data in Figure 5 are real; however, the airline's name is fictitious. The second page of the summary airline profiles presents origin and destination tables in the same format as in Table 1.

CONCLUSIONS

A number of national panels assembled in recent years to examine data resources and data requirements to support national transportation decision making have deplored the lack of data—even for aviation, the most data-rich of all modes. In many cases the problem lies in the difficulty of access to existing data rather than a dearth of data. Fixing this problem and proceeding incrementally from there appear to be the highest priority requirements.

This paper describes a project to tap existing data sets relating to the operation of HIA. The project provided an improved way to perform old tasks and a wealth of statistics and special analyses to support decision making at all levels. By supplying useful information (e.g., delay distributions), the project also facilitated newer activities within the Airports Division, such as airside and landside simulation that was almost at a standstill because of insufficient data.

Previously, most routinely used data sets were maintained at a coarse level of aggregation. With recent improvements in computer technology, such aggregation should no longer be the case, and reasonable levels of data disaggregation are possible. With improved data management methods, analysts are freer to take advantage of the rich disaggregate data to perform a multitude of special-purpose analyses continually (i.e., gate allocation and use, internal passenger traffic, baggage handling characteristics, time-of-day profiles, identification of peaking characteristics, etc.). Such detailed information would help fine-tune day-to-day operations, plan for improvements, and produce both macroscopic and detailed forecasts.

Behind these opportunities lurks a danger: inundation by data, or, as Schmitt stated, "Can we cope with sudden floods of new data, as happened when we started collecting flight delay information and swamped DOT with a sudden staggering flow of numbers to be transformed into useful information" (*1*). Part of the answer is not to let ambitious data collection plans outpace the ability to process and, more importantly, use these data for the purposes they are collected in the first place. These enhancements can be accomplished with a modest increase in staff positions, at a cost that is far outweighed by the benefits.

ACKNOWLEDGMENTS

This paper is based on the results of a project funded by the Airports Division, Hawaii DOT. The authors, who are solely responsible for the contents, appreciate the cooperation received by Airports Division personnel—especially Owen Miyamoto, Airports Administrator, and Gaylene Chun, Statistician.

REFERENCES

1. *Transportation Research Circular 352: Future Aviation Activities.* TRB, National Research Council, Washington, D.C., Feb. 1989.
2. *Transportation Research Circular 367: Proceedings of the Special Conference on Freight Transportation Data—The Changing Federal Role Since Deregulation.* TRB, National Research Council, Washington, D.C., Dec. 1990.
3. Data Resources for National Transportation Decision Making 1990. In *Transportation Research Record 1253,* TRB, National Research Council, Washington, D.C., 1990.
4. *Special Report 230: Winds of Change—Domestic Air Transport Since Deregulation.* TRB, National Research Council, Washington, D.C., 1991.
5. *Special Report 234: Data for Decisions—Requirements for National Transportation Policy Making.* TRB, National Research Council, Washington, D.C., 1992.
6. *Transportation Research Circular 407: Transportation Data Needs—Programs for a New Era.* TRB, National Research Council, Washington, D.C., April 1993.
7. *Hawaii Statewide Transportation Plan.* State of Hawaii Department of Transportation, Honolulu, 1991.
8. Papacostas, C. S., N. E. Synodinos, and G. M. Okimoto. Computer-Administered Surveys at the Honolulu International Airport. Presented at 72nd Annual Meeting of the Transportation Research Board, Washington, D.C., 1993.
9. Prevedouros, P. D., and C. S. Papacostas. *Honolulu International Airport: Statistical Analysis of Characteristics and Flows.* Report for the Airports Division, State of Hawaii Department of Transportation. Department of Civil Engineering, University of Hawaii at Manoa, Honolulu, 1993.

Publication of this paper sponsored by Committee on Airport Landside Operations.