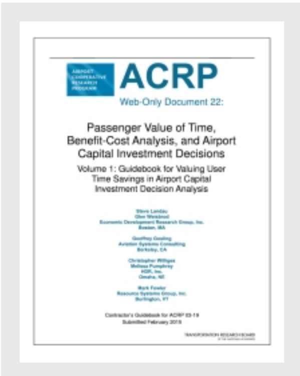

Passenger Value of Time, Benefit-Cost Analysis and Airport Capital Investment Decisions, Volume 1: Guidebook for Valuing User Time Savings in Airport Capital Investment Decision Analysis

DETAILS

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PREFACE AND OVERVIEW

This guidebook was prepared as part of *Airport Cooperative Research Program (ACRP) 03-19: Passenger Value of Time, Benefit-Cost Analysis and Airport Capital Investment Decisions*. The purpose of this research is to provide an up-to-date understanding of how recent airport developments, such as changes in security measures since 9/11, the proliferation of airside passenger amenities, and the adoption of new technology (e.g., Internet, mobile phone, wireless devices, and portable computers), have changed the way travelers value efficient air travel. For example, technology enhancements allow business travelers to conduct business on cell phones or computers while waiting for flights at airport gates. What was once “wasted time” can now become productive time. Similarly, air travelers can now often find a wider array of restaurants, products, and services available near gates than in the past. At the same time, security procedures have introduced new sources of uncertainty in time required to get to gates. Altogether, these types of technological and service shifts have the potential to change the way aviation system users value airport services and the airport capital necessary to provide efficient travel.

Travel time is often a significant consideration in benefit-cost analysis (BCA) for transportation projects and policies, and in recent years, there has been greater emphasis on use of BCA for airport capital investment. The Federal Aviation Administration (FAA) requires benefit-cost analysis for airport capacity enhancement projects funded through the Airport Improvement Program (AIP). Similarly, US Department of Transportation (USDOT) considers the result of cost-benefit analysis when selecting projects for discretionary funding programs, such as the recent TIGER (Transportation Investment Generating Economic Recovery) Program grant rounds. The Office of Management and Budget (OMB) has also long required the USDOT to estimate the incremental costs and benefits during Regulatory Impact Analysis (RIA) for rulemaking, such as occurred for the 2009 Enhanced Airline Passenger Protections (or “Passenger Bill of Rights”) rule.

The same need to understand the benefits and costs of investments applies to airport managers. Airports invest billions of dollars in infrastructure and service investments, yet airport owners and operators have relatively limited information on how customers value the impact of these investments. In addressing the question of how to best allocate limited resources, one can ask “would air travelers prefer improvements to the airport access roads, improved security processing times, or a people-mover connection between terminals?” This guidebook provides a method for airport owners and operators to determine how their customers value the travel time impacts of efficiency improvements.

The economic values presented in this guidebook are derived from a review of past research studies and a survey of air travelers conducted during the spring of 2013. The survey respondents comprised 1,260 travelers who made flights between 172 distinct origin airports and 148 distinct destination airports throughout the country. The results of the survey provide estimates of how travelers value their time for different segments of an air trip. A detailed description of the data collection methodology and results can be found in *ACRP Web-Only Document 22: Passenger Value of Time, Benefit-Cost Analysis, and Airport Capital Investment Decision, Volume 2: Final Report* at www.trb.org/Main/Blurbs/172473.aspx.

The value of time estimates presented in this guide represent a significant improvement over existing estimates. The latest FAA guidance on economic values for investment and regulatory benefit-cost analysis is dated October 3, 2007.[1] Yet, the values in that guidance are even older. The recommended hourly values of time savings are in 2000 dollars and derived from a 2003 Office of Aviation Policy and Plans (APO) bulletin[2] and a 2003 USDOT memorandum.[3] The USDOT guidance has since been revised, but even so the underlying research has not been updated. The guidance thus does not reflect the circumstances of contemporary travelers and it does not recognize the different valuations that occur at important stages of customers' airport experiences.

This guide provides updated travel time values that are specific to ten different segments of airport trips, differentiate between business and leisure travelers, and allow income levels to be taken into consideration. It describes a process for using travel time valuations in estimating the relative benefit or cost effectiveness of proposed airport capital investments. The process allows for decision makers to screen whether particular airport projects warrant the use of the more detailed values of time presented in this guide and to identify the types of travel time savings that are likely to occur for particular types of projects. The guidebook also provides three examples of applying the guidance that are based on different types of airport improvements, and provides recommendations for further research to improve and update the values of travel time savings and to enhance airport planning and investment analysis.

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[1] GRA Incorporated, *Economic Values for FAA Investment and Regulatory Decisions, A Guide,* prepared for FAA Office of Aviation Policy and Plans, Contract No. DTFA 01-02-C00200, Final Report, Revised October 3, 2007.

[2] FAA Office of Aviation Policy and Plans, *Treatment of Values of Travel Time in Economic Analysis,* APO Bulletin APO-03-1, March 2003.

[3] USDOT Office of the Secretary of Transportation, *Revised Department Guidance – Valuation of Time in Economic Analysis*, memorandum, February 11, 2003.

1 INTRODUCTION: VALUE OF TIME DEFINITION AND USE

1.1 What Is the Value of Time and Why Do We Care?

The value of time is a dollar amount assigned to value the benefit of a change in expected travel time or unscheduled delay resulting from transportation projects, policies, programs or events. For aircraft and airport operators, time delay can literally mean money lost insofar as they pay staff salaries regardless of whether aircraft are flying or sitting on the ground, and they often also incur overtime costs for late activity. For business travelers, employers may also be paying salaries of travelers, and incurring additional salary time without further benefit when flights are delayed. For travelers making personal trips, there is the value of their personal time, which reflects how much travelers would be willing to pay to reduce their travel time and can be measured by analyzing either their revealed or stated preferences. Revealed preferences can be seen by observing the willingness of travelers to incur extra costs for such time savings as more convenient parking, expedited check-in and security screening or express air services, or their willingness to save money by selecting less quick air service or through their airport choices. Stated preferences can be seen through their responses to surveys about how their behavior would change if confronted with proposed or hypothetical alternative scenarios.

The travel times and delays involved in making an air trip, and the relative value of reducing them, matter for a variety of reasons. First and foremost, they play a critical role in benefit-cost analysis, which is a consideration in aviation funding decisions. Specifically, the Federal Aviation Administration (FAA) requires benefit-cost analysis for airport capacity enhancement projects funded through the Airport Improvement Program (AIP). Similarly, the US Department of Transportation (USDOT) considers the result of cost-benefit analysis when selecting projects for discretionary funding programs, such as the recent TIGER (Transportation Investments Generating Economic Recovery) Program grant rounds. The US Office of Management and Budget (OMB) has also long required the USDOT to estimate the incremental costs and benefits during Regulatory Impact Analysis (RIA) for rulemaking, such as occurred for the 2009 Enhanced Airline Passenger Protections (or "Passenger Bill of Rights").

The magnitude and value of reducing the travel times and delays involved in making air trips apply to far more than just funding decisions. These factors are widely considered in aviation facility planning processes, airport design and operations decisions. They play a role in transportation-related decisions made by airlines, aircraft owners and operators, and travelers, as described in section 1.2 below. Yet valuing time becomes complicated, because values can vary for different types of situations. That aspect is discussed in section 1.3. This guide is intended to help transportation planners and airport operators better understand both the valuation of travel time and delay and how that valuation can be used.

1.2 How the Value of Time Is Used in Aviation Investment Analysis

The value of reducing the travel times and delays involved in making air trips may be relevant for five different types of decisions –project funding, facility planning, terminal design, airline service decisions, airport choice decisions and regulatory evaluations. Each category of decision is described in more detail below.

Project funding – Public funds are limited, so the OMB and FAA requires a benefit-cost analysis (BCA) for all major capital grants, which fund runway, taxiway, navigation aid and other airport improvement projects. This process identifies applications for projects that appear to have long-term societal benefits that exceed the long-term project costs. The typical categories of benefit for these projects are time savings for aircraft passengers and crew, and operating cost savings for aircraft. While this handbook will serve to guide airport managers, their consultants, and other stakeholders in valuing passenger time, it is important to also be cognizant of the breadth of benefit-cost analysis (BCA). BCA recognizes that improving capacity for aircraft movements (via runway and taxiway expansion), reliability for takeoffs and landings (via navigation aids, traffic management enhancements, or control tower enhancement), and terminal capacity (via expansion of apron space and gates) can reduce aircraft queues and diversions that waste crew time, aircraft operating costs while flying or moving or standing on the ground, and passenger time.[4] The consideration of benefits and costs is also not limited just to the FAA interest in airside improvements. In making funding decisions for investment in terminal and access road improvement projects, airport owners (which may be state or local government agencies, independent authorities or private companies) must also consider trade-offs between cost and user benefits to aircraft owners, passengers, and shippers from reductions in time and expense.

Facility Planning – Long-term planning is required for the development of land, buildings and equipment required to support aviation services. Planners recognize that evolving aviation demand (driven by shifting population, as well as changing social, technological and economic patterns) will require plans to be made for future investment in airports. These plans may include expansion or reconfiguration of groundside facilities (access roads, parking), terminals, and airside facilities (aprons, taxiways, runways, etc.). The value of time

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[4] Due to the extremely low incidence but extremely high consequences of aviation crashes, safety standards are typically a regulatory requirement rather than being established through airport-level BCA in the U.S. Similarly, security standards are a regulatory requirement than subject to airport-level benefit-cost consideration in the U.S.

is implicit (if not explicit) in the development of future airport facility plans, as planners recognize the value of reducing the time that the public has to spend time in such activities as circling within parking areas to find a vacant parking spot, waiting in queues for terminal check-in and security, or sitting in an aircraft that is either waiting to take off or waiting on the ground for an arrival gate to open up. At the same time, planners also recognize that use of aviation facilities is cyclical and varies over time, and it is financially unrealistic to provide sufficient capacity to totally eliminate all waiting and delays at peak hours, particularly on peak days of peak seasons. So they typically draw up plans to provide sufficient facility capacity to process passengers and aircraft in a "reasonable" period of time for the vast majority of the days and hours in a year. This is not merely a matter of peak demand at the nation's largest airports, for there also can be delays flying into small airports due to limitations of local navigation aids when inclement weather occurs. The value of time is implicit in the determination of what constitutes reasonable time delay.

Air Terminal Design – Local airport owners and operators try to adopt physical designs and operational configurations for processing passengers, crew, aircraft and supporting services in an effective manner. They commonly recognize that the time spent by airport users is ultimately determined by the "weakest link" in the flow process. So, whether a delay is associated with the access route or airport parking or airline check-in or security screening or getting to gates, in the end the occurrence of bottlenecks or delays anywhere in the passenger process can be viewed as an added time cost of using that airport. In areas where there is a choice of airports that can be used, the occurrence of delays can also make a difference in passenger decisions about which airports to fly through.

Airline Service Decisions – In a competitive market, airlines are acutely aware that reliability and on-time performance matter to customers. That is why on-time performance metrics are compiled and published monthly, and that is why airlines generally build some buffer time into their schedules. They are aware that any delay in airport terminal, aircraft gate, or runway activities can affect their schedule performance and ultimately customer choices of both airline and airport. Airlines also recognize that crew delay and aircraft delay beyond that allowed for in their schedules also becomes money spent and lost since they do not get any additional revenue to cover this. In the long run, this can become a factor in the air service offerings and schedule decisions of operators.

Airport Choice – In some areas, there is competition among airlines serving multiple airports in a region. In those cases, commercial airline passengers may have a choice of airport as well as airline, and may consider overall terminal access and processing time along with price as factors in their choice decisions. General aviation aircraft owners and a range of other air service providers (as well as aviation-related businesses, such as freight consolidators) may similarly view delays associated with airport access, aircraft handling, and takeoff or landing processes as a factor in their decisions regarding the airport at which to base their aircraft or use for their activities. This study focuses specifically on value of time factors relating to passenger delays at commercial airports, though many of the same factors may apply for general aviation (including corporate jets) and air cargo.

Regulatory Evaluations – All proposed major regulations are subject to BCA analysis by the FAA.

1.3 Why the Value of Time Varies

The value of time represents what people are willing to pay to save time, or added time that they are willing to incur to save some expense. It is known to differ by trip purpose and mode. For instance, the USDOT official guidance recognizes that business travelers tend to assign a greater value to travel time savings than do people making personal trips. Moreover, the USDOT guidance assigns a higher value of time to those who travel between cities by air than those who rely on buses or cars for those journeys, reflecting the fact that air travelers are paying a premium for faster travel. In addition, transit planners often recognize that travelers give a higher value to reducing time spent waiting at a bus stop (particularly in inclement weather) than to saving time while riding a bus. These differences are not small; for instance, the value of an hour spent in business travel is typically double that for personal travel.

While these differences fundamentally make sense, they do give rise to further complexities. For instance, when a person drives to an airport and then flies to another city, the value of time attributed to that same person is different for the airport ground access leg of the journey than for the airline part of the journey. In other words, these differences value travel time improvements in ground access to an airport differently than travel time improvements while flying from that airport. The differences also leave ambiguities about where to draw the line between the valuation of savings in different segments of the trip, such as parking at the airport and checking in at the airline counter inside the terminal.

Is it worthwhile to keep or expand the use of different values of time for different types of travel? Despite the challenges that they present, the answer is unequivocally yes.

Travelers tend to have good reason for differences in their value of time, which reflect not only differences in trip purpose, but also systematic variations in the level of comfort, reliability and usefulness of time spent during various parts of a trip. For instance, an air passenger who is delayed while sitting at a gate waiting for a flight may spend that time working on a computer, reading or talking on the phone – all more useful to the individual than standing in a security line where none of those activities are possible.

1.4 How this Guide Can Help

This guidebook utilizes information from a national survey of air travelers to show how the value of time for airline passengers varies between different segments of an air journey, and to further show how that information can be used to better prioritize and optimize proposed airport improvements. It also provides a workbook for benefit-cost studies which allows for different types (or packages) of proposed capital investments to incur different values of time for passengers, depending on where in the travel process those passengers are expected to save time. Lastly, it shows how the updated air travel values of time can be reconciled with values for ground transportation modes.

The guidebook is designed to enable more accurate application of benefit-cost studies for proposed airport improvement projects by expanding and enhancing passenger value of time calculations. It is designed to be applicable for conducting benefit-cost analysis compliant with FAA grant requirements. However, it may also be used by airport operators and airlines for their own planning and funding decisions.

This guidance focuses exclusively on the valuation of time savings for passengers who use commercial airports. It does not cover the value of time savings for airport or airline staff, vendors located in airports, cargo shippers, ground transportation providers, or others who work at the airports. Air cargo shippers also benefit from improvements in travel times and reliability, but that valuation varies widely depending on the perishability and delivery time sensitivity of specific types of cargo – a matter that is beyond the scope of this study.

The remaining pages of this document provide guidance for the use of value of time measures in aviation project analysis. The next chapter explains the logic of a five-step analysis process and issues to be confronted in developing time savings measures for its use. The five steps are described in the chapters that follow, followed by illustrative examples showing how they work differently for three types of projects – runway, ground access and navigation aid improvements. A final chapter discusses issues that arise in applying the recommended values of time and how they can be updated as needed in the future.

2 METHODOLOGY FOR VALUING AVIATION TRAVEL DELAY

2.1 Value of Time Breakdown by Trip Segment

As part of this study, the project team conducted surveys of 1,260 passengers traveling on flights between 172 different origin airports and 148 different destination airports throughout the United States. These were "stated preference" surveys; they asked travelers to select among various combinations of alternative scenarios that involved (a) different times to complete various segments of trips, as well as (b) different trip costs. By observing the respondent choices and the trade-offs that are effectively made in those selections, it becomes possible to calculate the effective "willingness to pay" for time savings related to different segments of aviation passenger trips. A detailed description of data collection methods and results can be found in *ACRP Web-Only Document 22: Passenger Value of Time, Benefit-Cost Analysis, and Airport Capital Investment Decision, Volume 2: Final Report* at www.trb.org/Main/Blurbs/172473.aspx.

The passenger survey results enabled calculation of the value of time for ten distinct segments of airport-to-airport travel, which are grouped into four primary classes:

- *Ground access* time (departure) and ground egress time (arrival)
- *Terminal groundside (departure)* - Terminal access time (parking, shuttle bus), check-in and security screening time, time to reach the gate area, gate time
- *Airside (flight)* - Flight time, including boarding time and time to connect between flights at an intermediate airport, unexpected flight delay
- *Terminal groundside (arrival)* – Time to reach baggage claim or exit the terminal (if no checked bags), baggage claim wait time and time to exit the terminal with claimed bags

Additional values for ground access and egress time were drawn from those previously set by USDOT for road travel associated with intercity trips. The recommended values are shown in Table 1. In each case, the values have been rounded to the nearest $0.05 to be consistent with previous USDOT value of time guidance and to avoid the appearance of false precision.

Besides showing values of time for business and leisure travelers, the table also shows an airport composite. The airport composite was calculated using the distribution of business (40.4 percent) and leisure (59.6 percent) travel reported in the 2001 National Household Travel Survey. This source was used to estimate composite values in the latest USDOT value of time guidance. The composite is designed for use only in those situations where information on the trip purpose of traveling passengers is unavailable.

In general, this table shows how travel time varies among trip segments in ways that reflect differences in comfort, amenity and ability to conduct other work during that time. For instance, the higher value of time associated with airline check-in and airport security processes reflects the more onerous nature of those trip segments, which require standing and generally preclude more productive uses of that time. The lower value of waiting time at airport gates reflects the usually more comfortable sitting options available, as well as the increased ability of users to talk on cell phones, read or use computers during that time.

Table 1: Value of Time Savings per Hour (2013 values in 2013 dollars)

Time Category	Value per Hour of Time Savings		
	Business	Leisure	Airport Composite
Ground access and egress			
Ground access time	$18.60	$16.95	$17.60
Ground egress time	$18.60	$16.95	$17.60
Terminal groundside (Departure)			
Terminal access time	$33.85	$26.00	$29.15
Check-in and security time	$37.20	$28.45	$32.00
Time to reach gate area	$32.25	$22.85	$26.65
Gate time	$20.50	$17.60	$18.75
Airside (Flight)			
Flight time (incl. connections)	$51.00	$34.90	$41.40
Unexpected flight delay*	*$286.30*	*$123.30*	*$189.15*
	See Note Below		
Terminal groundside (Arrival)			
Time to reach bag claim / exit	$32.25	$22.85	$26.65
Baggage claim wait time and exit	$37.20	$28.45	$32.00

Source: ACRP 03-19 National air passenger survey

**The value of time for unexpected flight delay is a function of both the frequency and magnitude of flight delays and is not necessarily equivalent to a 'per hour of delay' value. For example, if the percentage of flights that were shown as on-time in a given alternative was 60% (i.e. 40% of flights were delayed) and the corresponding delay shown was 30 minutes, the expected delay was calculated as 0.4 x 30 = 12 minutes.*

*In the flight itinerary survey a 100% certainty for an hour of delay was calculated at $286.30 for business travelers, $123.30 for leisure travelers and as $189.15 as an airport composite. The following is an example of how to use these values to calculate the value of time for unexpected flight delays. Consider an airport where approximately 26% of flights are delayed. (Delay frequencies are available from the Bureau of Transportation Statistics.) Let's assume a capital investment will reduce the average time of delay by 65 minutes for those delayed flights. The expected value of delayed minutes is 0.26 x 65 = 17 minutes. Using the values for business and leisure travel cited above, a business traveler would be willing to pay 17/60 * $286.32 = $81 for a scenario where there is no chance of being delayed (the expected value of delay is zero minutes) and a leisure traveler would be willing to pay $35.*

For a specific BCA, it is important to limit the analysis to the delayed passengers that might be affected by a proposed investment. For example, a weather-related improvement would not be expected to benefit passengers delayed due to airline mechanical issues.

Ground access time values were estimated from the survey data to be $18.60/hour and $16.95/hour for business and leisure trips, respectively, which are lower rates than the value of time guidance published by the USDOT for both local and intercity trips for use in cost-benefit analyses. The values estimated from the survey data, while not identical, are comparable to the USDOT intercity values of $24.60/hour and $17.55/hour (in 2013 dollars) for business and leisure trips, respectively. However, there are a couple of points to note about making such a comparison:

a) The USDOT value of time reflects a single value for all components of long-distance intercity travel, while the survey-estimated value of time reflects specifically the airport access component of that travel, unique to air trips. Airport access is clearly a different type of trip component. The survey-estimated values are higher than the USDOT guidance for local travel, which is consistent with past research conducted by RSG and others (ACRP Synthesis 5, "Airport Ground Access Mode Choice Models").

b) The values from the USDOT guidance were estimated as a function of wage rates of survey respondents. While this is a reasonable assumption, there is a large amount of uncertainty related to such an assumption. Past research has found that travelers' values of time can vary from 20% to 100% or more of household hourly wage rates depending on the region, trip characteristics, and respondent characteristics. NCHRP Report 431, "Valuation of Travel-Time Savings and Predictability in Congestion Conditions for Highway User-Cost Estimation" (TRB, 1999), summarizes research by Small and Waters which suggests that the value of time for work trips is about 50 percent of the wage rate on average and that it varies with income or wage rate but not necessarily proportionally. However, Small ("Urban Transportation Economics," 1992) observed significant variation around this 50 percent average, explaining that values of time vary among different industrialized cities from perhaps 20 to 100 percent of the gross wage rate, and among population subgroups by even more. The stated preference survey seeks to estimate these values directly from travelers who recently made an airport access trip rather than being inferred from the wage rates of respondents.

Secondly, the values of the time to reach baggage claim and/or exit the terminal, baggage claim waiting time, and ground egress time were not estimated directly from the results of the passenger survey, because the survey focused specifically on the outbound departing segment of the air trip and the arriving portion of the trip was not covered in the survey. For these values, it was assumed that the value of the time to reach baggage claim and exit the terminal is the same as the value for the time to reach the gate area after clearing security on the departing segment of the trip, the value for the baggage claim waiting time is the same as for check-in and security time, and that for ground egress time is the same as for ground access time. It could be argued that these values might be less since the consequences of missing an outbound flight are more severe than the consequences of taking more time to reach events or meet family, friends and business associates at the arrival end. There may also be time-of-day considerations that may differ between airport access and egress trips. The effect of these factors on the values of time would be useful issue for future research to investigate.

A further breakdown of the value of time by the personal income level of air passengers is shown in Table 2. In general, it shows that higher income travelers tend to report a higher value of time than lower income travelers, as would be expected.

Table 2: Value of Time Savings per Hour (2013 values in 2013 dollars)

Time Category	Personal Income		
	Less than $75,000	$75,00 - $199,999	$200,000 and More
Business Travelers			
Ground access time	$13.90	$21.32	$38.49
Terminal access time	$23.75	$36.35	$65.65
Check-in and security time	$27.75	$42.45	$76.70
Time to reach gate area	$22.65	$34.60	$62.55
Gate time	$14.25	$21.80	$39.35
Flight time	$33.65	$58.90	$101.00
Unexpected flight delay	$186.35	$326.10	$559.00
Time to reach bag claim / exit	$22.65	$34.60	$62.55
Baggage claim wait time and exit	$27.75	$42.45	$76.70
Ground egress time	$13.90	$21.30	$38.50
Leisure Travelers			
Ground access time	$14.55	$16.65	$22.15
Terminal access time	$22.10	$25.20	$33.60
Check-in and security time	$24.25	$27.70	$36.90
Time to reach gate area	$19.25	$22.00	$29.30
Gate time	$14.90	$17.05	$22.65
Flight time	$30.05	$41.20	$95.45
Unexpected flight delay*	$107.10	$146.75	$340.15
Time to reach bag claim / exit	$19.25	$22.00	$29.30
Baggage claim wait time and exit	$24.25	$27.70	$36.90
Ground egress time	$14.55	$16.65	$22.15

Source: ACRP 03-19 National air passenger survey

**See the note under Table 1 for guidance on how to interpret and apply the value of time for unexpected flight delay.*

Table 2 shows the value of time by personal income. However, it is more common for passenger surveys to request "household income" than "personal income" because requesting household income is considered a less intrusive question, and will receive a greater response rate than inquiries about personal income. In the case when an analyst has “household income” data, it becomes necessary to convert these data into “personal income” This guidebook suggests two methods for this type of conversion:

1) The 2012 Statistical Abstract of the United States reports U.S. median household income at $50,221 (Table 706) and per capita personal income at $36,697 (Table 678). Household income can be converted to personal income by applying this ratio ((36697/50221=0.731)* (household income)); or

2) The stated preference survey conducted for this project included questions for both personal and household income. The percentage of survey respondents in each household income range who reported a personal income in the ranges shown in Table 2 is shown in Table 3. Therefore, if the household income of air passengers by income level is known, the analyst can multiply the number of passengers in each household income stratum by the appropriate percentage from Table 3to give the estimated number of passengers in each personal income range. If the household income ranges in the air passenger survey differ from those shown in Table 3, it will be necessary to interpolate the percentages in each household income range used in the survey. Note that if the air passenger survey from which household income data was obtained was performed in a different year from 2013, it will be necessary to adjust the household income ranges in the survey to 2013 dollars and for changes in real incomes between the year of the survey and 2013 for consistency with the data in Table 2 and Table 3.

The first approach is considerably easier to apply. However, the second of these two methods is likely to give a more reliable result, since the ratio of personal income to household income varies with the household income level and reflects data for a representative sample of air passenger trips, rather than households in general.

Table 3: Proportion of Air Passengers in Each Personal Income Range by Reported Household Income (2013 values in 2013 dollars)

Household Income	Personal Income		
	Less than $75,000	$75,000 - $199,999	$200,000 and More
Business Travelers			
Less than $75,000	100%		
$75,000 - $99,999	27%	73%	
$100,000 - $149,999	19%	81%	
$150,000 - $199,999	6%	94%	
$200,000 - $249,999	7%	56%	37%
Leisure Travelers			
Less than $75,000	100%		
$75,000 - $99,999	37%	63%	
$100,000 - $149,999	31%	69%	
$150,000 - $199,999	12%	88%	
$200,000 - $249,999	15%	41%	44%

Source: ACRP 03-19 National air passenger survey

2.2 Analysis Elements

The pages which follow lay out a five-step screening and planning process that can be used when considering the value of travel time and delay reduction associated with a proposed project. This sequence is illustrated in Figure 1 and explained in the text that follows the figure. The five-step process is designed to minimize the work effort involved in applying the analysis approach, by keeping the analysis required to an absolute minimum.

Figure 1: Five-Step Process for Estimating Value of Efficiency Improvements

The five steps are:

- *Step 1: Screen Project for Applicability* – Conduct a screening process to determine whether it is even necessary to measure impacts of different types of time savings for a particular project. This will depend largely on the type of airport improvement project and magnitude of difference that it is expected to make in air passenger travel times.

- *Step 2: Identify Relevant Time Categories* - For projects that pass Step 1, identify the specific categories of air, ground and/or terminal delay that are expected to change because of the given type of project.
- *Step 3: Calculate Change in Travel Times* - Determine the difference in travel time or travel delay between "implement improvement" and "base case" scenarios for each of the categories identified in Step 2.
- *Step 4: Calculate Value of Change in Travel Times* - Apply relevant values of time to the travel time/delay changes identified in Step 3 to represent the value of the user time benefit. The values of time come from a combination of past research and new survey results.
- *Step 5: Apply to Benefit-Cost Analysis* – Determine the portions of all passenger trips affected by the proposed improvement, and apply the Step 4 results for that portion of trips, as would be done for any standard benefit-cost analysis.

These steps are explained in detail in Chapter 3. The rest of this chapter discusses issues regarding both the measurement of delay and its impact on traveler behavior.

2.3 Analysis Issues Regarding Measurement of Delay

Readers using this guide should be aware of several aviation-specific issues that need to be considered in the measurement of travel time and delay and the benefit of reducing these. These issues are discussed below, and ultimately affect the measurement of changes in travel time and delay in step 3.

- ***Buffer Times*** – Airlines include "buffer" times in published schedules to allow for travel time variability and unpredictable delay circumstances. As a result, some airport improvements reduce delays yet have little or no effect on airline on-time performance (at least in the short run). Likewise, passengers typically also leave extra time to allow for potential delays in reaching the airport, check-in, and security procedures when deciding when to leave for the airport. Travelers may also allow extra time for transfers between connecting flights when selecting among flight options. In the short run, these buffers tend to conceal some or all of the travel time savings resulting from airport improvements. In the longer run, though, airline and passenger decisions regarding schedule padding and expected travel time can change with shifts in the perceived length and variability of ground access and passenger processing times at a given airport
- ***Volume/Capacity Threshold Effects*** – Aviation operations are regulated by rules that determine the spacing between takeoffs and landings that constrain the number of operations in a particular time period; also airlines use business models that influence routes and airports served. As a result, some airport improvements may not generate enough additional capacity to immediately exceed the threshold needed to allow air service to increase or to change an airline's business case.

However, capacity thresholds may be reached at a future year as air traffic grows as a result of the improvements. The analyst must ensure that volume/capacity threshold effects are taken into account, because they can affect the delay calculations and their valuation over the lifecycle of a benefit-cost analysis.

- ***Relationship between Airside and Groundside Activities*** at an Airport and within the Airport Network– The journey for an air traveler includes the flight, time spent at arriving and departing airports, as well as ground access and egress. The flight and the airport portions of a trip are connected through airport operations and flight control. As an example, congestion at one airport may require incoming flights to be delayed prior to leaving their origin airports, typically through an air traffic control ground delay program or ground halt, and passengers may spend time waiting in the gate area at their origin airport

2.4 Analysis Issues Regarding Impact of Changes in Travel Time and Delay on Passenger Behavior

Readers using this guide may also consider the relationship between capital investment in airport improvement and resulting effects on air passenger behavior. These issues are discussed below, as they ultimately affect both the use and interpretation of benefit-cost calculations that rely on value of time factors.

- ***Value of Shifting Use of Time*** - Capital investments that result in passengers spending less time in one segment of the trip and more time in another (e.g., a people mover allowing passengers to spend more time in the gate area) has value if the passengers find the additional time spent in the downstream activity is a preferable way to spend time (has a lower value of time savings). That is, after all, a major purpose of estimating different values of time savings for different components of the trip. It should be noted that terminal expansions can increase the time needed for passengers to move through the proposed larger facility, excluding time spent in-lines or being processed through security or check-in, although expanding processing facilities can reduce queueing delays. Therefore project-specific analysis will be required to explore the trade-offs involved. This guide enables the issue to be directly considered.

- ***Operations Associated with Capital Investment*** - Whether capital investments in passenger check-in and screening facilities will affect time delay spent in those facilities of course depends on whether the expanded facilities are adequately staffed. It is self-evident that constructing facilities that are not used does not affect delays (although the time spent waiting may be less unpleasant in more spacious facilities). Conversely, increasing the staffing levels in already constrained facilities has limited ability to reduce delays. Provision of self-check-in equipment can reduce passenger waiting time, but involves a capital investment (although the benefits of this include reduced staffing costs as well as potentially less space for queueing).

Users of this guide must therefore take care to ensure that BCA of any capital investment accounts for the change in labor (as well as capital) costs involved in reducing airport user time.

- ***Reduction in Overall Trip Time*** – At one level, there is no doubt that some airports require more time than others for travelers to get through the processes of access, check-in, security and travel to the gate. And there is little doubt that many travelers consider those factors in setting their ground access and air travel schedules. Yet there remains a fundamental question as to how capital investments that reduce the time spent in different segments of air trips ultimately affect passenger schedule and flight choice decisions. In other words, to what extent are savings in specific segments of a trip additive in their impact on total trip times? Current calculation methods effectively assume that time savings associated with different trip segments are indeed additive – i.e., they affect total trip time. However, further research is needed to better understand actual traveler behavior in their decisions regarding this matter.

- ***Variability in Travel Times*** – The time that an air passenger spends in each segment of an air trip will vary from day to day and from hour to hour on a given day, depending on the level of activity, staffing levels, congestion on the regional highway system, and other factors. In deciding when to leave their trip origin for the airport, and even which flight to take, passengers typically make some allowance for encountering unforeseen delays in different segments of their trip. If those delays do not occur, or are less than allowed for, then passengers will arrive at the airport or their gate earlier than strictly necessary. If delays in one segment of the trip (e.g. airline check-in) are less than allowed for, this provides some additional margin in case delays in another segment (e.g. security screening) are greater than expected.

  If the variability in the times that are spent in each segment for the trip can be reduced, air passengers can reduce the additional time allowance they make to cope with this variability. This can represent a significant saving of time that may be more valuable to them than reducing the time spent in specific segments of the trip from their origin to the gate, which may only result in them spending more time at the gate before their flight. Therefore if an airport capital investment project reduces the variability of air passenger travel times as well as the average travel times, additional travel time benefits can be delivered, which should be taken into account in assessing the benefits of the project. The research undertaken for ACRP 03-19 did not attempt to estimate different values of time for reductions in travel time variability compared to reductions in average travel times, although this would be a worthwhile topic for future research. Thus, absent future research results and guidance on this aspect, it is recommended that the values of time given in chapter 2 be used for changes in both average travel times and travel time variability.

3 FIVE-STEP PROCESS

Step 1: Screen Project for Applicability

It takes extra time and effort to adjust benefit-cost studies to incorporate different values of time savings for different segments of the air passenger trip, and that extra effort is not always necessary. So the first step is to apply a project "screener" to identify whether the extra effort is necessary that allows the analyst to identify likely passenger travel time savings. In this way, the analyst can save time by determining immediately whether or not it is worthwhile to use the different values of time for different segments of the total trip described in this guidebook for a given project.

The screening process focuses on passenger travel time savings. Most airport improvement projects are actually packages or combinations of elements. Some are designed to reduce time delays for air passengers, while others are designed to reduce operating cost, enhance safety or amenities, or otherwise improve operational efficiency or throughput. As a result, many projects will involve improvements that do not necessarily save time for air passengers.

The **Project Screener** is shown on the next page in Table 4. The screener provides a list of project types that may be elements of a broader project package. The list of project types is intended to be illustrative and not exhaustive. The screener also lists classes of potential actions and shows whether or not the project is likely to save time for passengers. The analyst should identify the types of project elements and associated actions that are applicable, and then consider whether or not that action appears to warrant analysis of passenger time savings. The analyst should focus on the aspects of the project that are likely to generate relatively large travel time savings.

Table 4: Project Screener

Project Type	Action Type	Effect on Time Delay	
		Yes (potentially)	No
Airport (non-terminal) - Airside			
Air Traffic Control (usually not an airport responsibility)	Upgrade	Incresases airport capacity, which may reduce aircraft delays	
Aircraft Ground Control (usually not an airport responsibility)	Capacity	Save time in waiting to take off	
Runway	New, expanded or enhanced	Reduce aircraft delay via higher throughput rates/use of larger aircraft, more (longer distance) direct flights	
	Maintain, repave		X
	Enhance (safety areas, lighting drainage, grading)		X
Taxiways	Expand or improve	Reduce aircraft delay by enabling faster aircraft exitfrom runways or reducing taxiway congestion	
	Maintain, repave		X
Apron Area, Taxilanes, and Aircraft Gate Positions	Expand area	Reduce aircraft ground delay waiting for a gate to become available	
	Maintain, repave		X
Hangers, Tie-Downs	Add number		X
Maintenance Facility	Expand		X
Cargo Complex	Handling Capacity (aircraft, tonnage)		X
Airport (non-terminal) – Groundside			
Access Road to Airport	Add lanes, increase travel speed	Reduce congestion delay, save travel time	
People Mover Access to Airport Terminal (from Transit, Rental Car or Parking Facilities)	Construct; or add frequency, increase speed	Reduce waiting delay, save travel time	
Parking Lot/ Garage	Capacity, travel time, driver information systems	Reduce in-vehicle search time for parking space or out-of-vehicle walking time from garage to terminal	
Central Bus or Train Transfer Facility to/from Airport Terminal	Capacity, travel time	Reduce wait time, walk time	
Airport Circulation Improvments for Taxis	Add capacity	Reduce wait time, walk time	
Drop-off & Pickup Areas by Terminal Curbfront	Add Capacity	Reduce wait time, walk time	

<table>
<tr><th rowspan="2">Project Type</th><th rowspan="2">Action Type</th><th colspan="2">Effect on Time Delay</th></tr>
<tr><th>Yes (potentially)</th><th>No</th></tr>
<tr><td colspan="4">Terminal – Airside</td></tr>
<tr><td>Aircraft Gates</td><td>Number, aircraft size</td><td>Reduce delays to arriving aircraft waiting for a gate to become available or rub-off delays to departing aircraft</td><td></td></tr>
<tr><td>Seat Capacity at Gates</td><td>Expand</td><td></td><td>X*</td></tr>
<tr><td>Walkway to Gates</td><td>Provide moving walkway or people mover</td><td rowspan="2">Reduce time getting to gate, but potentially offset increased wait at gate</td><td></td></tr>
<tr><td>Moving Walkway or People mover to Gate</td><td>Capacity, frequency, travel time</td><td></td></tr>
<tr><td colspan="4">Terminal - Landside</td></tr>
<tr><td>Passenger Check-in</td><td>Add positions</td><td>Savings due to faster check-in</td><td></td></tr>
<tr><td>Passenger Screening (TSA)</td><td>Add lanes and other capacity enhancements</td><td>Reduce passenger wait time</td><td></td></tr>
<tr><td>Baggage Handling</td><td>Improve inbound baggage facilities</td><td>Save wait time to pick up baggage</td><td></td></tr>
<tr><td>Baggage Claim</td><td>Expand claim devices</td><td>Save wait time to pick up baggage</td><td></td></tr>
<tr><td>Food Court, Shops</td><td>Expand or enhance</td><td></td><td>X*</td></tr>
</table>

** The perceived value of time spent in the gate hold area, food court or other terminal concession areas may be influenced by comfort and enjoyment levels, but the derivation of the values given in the Guidebook did not attempt to measure these effects.*

Step 2: Map Project to Time Categories

The second step helps the analyst determine the time categories affected by the project. Time categories are portions (or segments) of an air passenger's trip that have different values of time. This guidebook recognizes the ten time categories shown in Figure 2.

Figure 2: Time Categories for Aviation Trips

Ground Access and Terminal - Departure

Ground Access	Terminal Access	Check-In/Security	Reach Gate Area	At Gate

Airside

Flight Time	Flight Delay

Terminal and Ground Egress - Arrival

To Bag Claim	Baggage Claim	Ground Egress

These categories are defined as follows:

- *Airport Ground Access Time:* The travel time from a passenger's origin to a parking location, drop-off location, or transit stop/station at the airport.

- *Terminal Access Time:* The time to reach the airport terminal from the parking location, drop-off location, or transit stop/station.
- *Check-in and Security Time:* The time to check-in and check baggage, reach security screening, wait in line and clear security. Not all passengers check-in or check bags at the airport. There is no reason to believe that the disutility associated with waiting at check-in would be different from the disutility of waiting at security screening.
- *Time to Reach the Gate Area:* The time spent getting to the gate area after clearing security.
- *Time at Gate:* The time after reaching the gate area until boarding commences, including any time spent in airport concessions after clearing security.
- *Airport-to-Airport Flight Time:* The total scheduled airport-to-airport travel time, time spent for taxi, takeoff and landing, in-flight time, and time spent at connecting airports.
- *Flight Delay Time:* Any increase in the above airport-to-airport flight time.
- *Time to Baggage Claim or Terminal Exit:* The time passengers spend walking from the arrival gate to the baggage claim area or terminal exit. The ACRP 03-19 research did not directly address the time to reach the baggage claim area or terminal exit, but it is reasonable to believe that the disutility associated with this is the same as that involved in getting to the gate area after clearing security on departure.
- *Wait Time at Baggage Claim and Exit Terminal:* The time passengers spend in the baggage claim area waiting for baggage to arrive and subsequently exiting the terminal. The ACRP 03-19 research did not directly address wait time at baggage claim or exiting the terminal, but it is reasonable to believe that the disutility associated with waiting at baggage claim and then exiting the terminal is the same as that at check-in and security screening.
- *Airport Ground Egress Time:* The travel time from the airport to the passenger's destination. The ACRP 03-19 research did not directly address egress time, but it was assumed that the value of egress time is roughly equal to that for ground access.

The analyst starts by identifying the relevant project elements from Step 1. These are then mapped to the ten time categories using the matrix shown in Table 5. A project may involve elements of multiple project types. In such a case, the analyst should note the time categories for each of the relevant project types.

In addition, the analyst should take into account the caveats noted in the introduction. For example, a runway project may reduce delays and provide more direct flights. These lead to time savings at the gate or in-flight times, but the magnitude of the impact can vary depending on the buffer times included in airline schedules and travel time margins allowed by passengers.

Table 5: Time Impact Mapping Matrix

Project Type (Elements)	Ground Access	Terminal Access	Check-In and Security	Reach Gate	At Gate	Flight Time	Flight Delay	To Bag Claim or Exit	Baggage Claim	Ground Egress
AIRSIDE										
Air Traffic Control						X	X			
Runway					X	X	X			
Taxiways						X	X			
Apron Area, Taxilanes and Aircraft Gate Positions						X	X			
GROUNDSIDE										
Access Road to Airport	X									X
People Mover Access to Airport Terminal (from Transit, Rental Car or Parking Facilities)		X								X
Parking Lot/Garage		X								
Central Bus or Train Transfer Facility to/from Airport Terminal*		X								X
Airport Circulation Improvments for Taxis		X								X
Drop-off & Pickup Areas by Terminal Curbfront		X								
TERMINAL LANDSIDE (DEPARTURES)										
Passenger Check-in			X							
Passenger Screening (TSA)			X							
People Mover to Gate				X						
Aircraft Gates						X	X			
TERMINAL LANDSIDE (ARRIVALS)										
People Mover from Gate								X		
Baggage Handling									X	
International Arrival Facilities			x**					x	x	

** If remote passenger processing available, it be treated in the same way as at the airport.*

***Queueing and processing in customs and immigration is assumed to have the same value of time savings as for security screening.*

Step 3: Calculate Travel Delay

The third step calculates the size of the travel delay with and without the project (or the net time savings). All time savings come from two fundamental drivers: (1) a reduction in the size of queues that form because of insufficient capacity at some part of the airport, or (2) a technological improvement that reduces the time required for travelers to complete some step in the process of getting through the airport to or from their flight or an improvement in the functioning of some transport element that allows people to move faster between key points.

- Most commonly, an airport project is intended to enhance capacity to meet anticipated future demand. In many of these cases, there is acceptable queue delay today and the project is intended to insure that delays remain acceptable in the future.[5] However, to show the time benefit, it is necessary to identify the potential source of queues being addressed. This makes it possible to compare anticipated future conditions with the project against a base case in which current capacity conditions prevail, so that the avoided delay can be calculated.
- Time savings that do not involve capacity bottlenecks typically result from some improvement in the service frequency or speed of moving walkways, people movers, or other technologies involved in moving people from parking or other ground access facilities to the terminal, or from the check-in area to gates, or from gates to remotely parked aircraft, or from the application of some technology that saves travelers time, such as parking guidance systems that direct drivers to the closest available space.

For projects that involve relief or avoidance of current or potential future capacity constraints, it is useful to consider that the effect of such constraints is more severe at peak times. In addition, a higher proportion of business passengers (who have higher values for their delay) are likely to travel at peak times.[6]

Not all airports have information about the trip purpose split (i.e., business versus leisure) of airport passengers, let alone how passenger characteristics vary between peak and off-peak times. Thus, this guidebook does not require that information to calculate the passenger travel time benefits. However, having these data available may result in higher benefit values, because using daily average passenger values to estimate travel time benefits underestimates the severity of passenger queues that occur at peak times, and using a composite value of time (that averages both business and leisure travel) will fail to account for the effect of greater business use during peak periods.

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[5] Even in situations with adequate capacity for existing traffic levels, some queues may form in peak periods.

[6] Exceptions to this general rule may include airports that are located at major vacation destinations, including those serving major cruise ship ports.

If possible, the analyst should obtain relevant air passenger characteristics and passenger activity information along with capacity information to calculate total aggregate time savings for the classes of travel shown in Table 6. This information can be transformed into percentages that can then be applied as weighted averages to the values developed next in Step 4.

Defining Peak Periods

Peak periods will vary by airport. Some airports may have seasonal peaks (for example, ski season); others may peak for a particular week (spring beak). All airports will experience varying levels of passenger activity by time of day. For example, a major business hub may experience peak passenger activity during the first morning bank of arriving and departing flights, as business travelers are departing or arriving for meetings, or boarding connections to smaller cities. Similarly, a peak period may occur in the late afternoon and early evening as business travelers are departing for home and returning home. Because regional characteristics are rarely homogeneous, and local residents on personal travel contribute to peak passenger volumes, determining an airport's peak period requires an analysis of hourly counts of arriving and departing passengers by day of the week to observe when peaks occur. Weekend days should be part of this analysis, to account for vacationers and other personal trips. This analysis is typically done for the peak month of the year, although it may be appropriate to consider other months as well if travel patterns vary widely during the year.

In some cases the airlines serving an airport may be willing to provide passenger counts by flight or by hour of the day. Where these data are not readily available it is common practice to record arriving and departing aircraft seats by hour from the flight schedule and apply the average load factor for each airline and aircraft type for that month (which is available from the monthly data reported by each airline to the USDOT on Schedule T-100 and available on the Bureau of Transportation Statistics website or from a number of commercial sources). However, in performing this analysis there are a number of issues that need to be taken into account:

- Peaks of arriving and departing passengers may occur at different times.
- Aircraft passenger loads include connecting passengers, who may not be using some of the airport facilities (e.g., airline check-in or baggage claim). Therefore it may be necessary to adjust the aircraft passenger loads for connecting passengers, particularly at airline hubs.
- Aircraft load factors (the percentage of seats occupied by passengers) are likely to be higher during peak periods than off-peak periods. However, there is no way to determine how much higher from the USDOT data, which only provide monthly totals of passengers and seats for each nonstop flight segment. Nonetheless, making adjustments to the reported load factors to give assumed peak and off-peak load factors on the basis of judgment is likely to give more accurate results than ignoring this aspect completely. A reasonable approach might be to assume that the

peak period load factor is mid-way between the average reported load factor and 100%, and adjust the off-peak period load factor accordingly to give the correct average load factor overall (this type of adjustment will depend on the proportion of seats in the peak period).

- Departing passengers will arrive at the airport some time before their scheduled flight departure, typically an hour or more. Therefore the peak demand on many airport facilities, particularly those earlier in the departure process, such as terminal access services, airline check-in, and security screening, will typically occur in the hour before the hour with the greatest number of departing seats. On the other hand, it takes some time for all the passengers on a flight to deplane after the flight has arrived and proceed through the terminal to baggage claim and ground transportation, so the peak demand for facilities used by arriving passengers will typically occur in the half-hour after the half-hour with the greatest number of arriving seats. Thus performing the analysis on the basis of half-hourly rather than hourly periods is likely to give more accurate results.

Table 6 shows a typical worksheet that can be used to classify passenger activity at an airport by trip purpose and peak/off-peak periods.

Table 6: Breakdown of Passengers by Trip Purpose and Period

Type of Traveler	Peak Period	Off-Peak Period	Total
Business			
Leisure			
Total			

If the Table 5 matrix (shown earlier) shows that a project may affect gate, flight time or flight delays, then it can also be useful to distinguish between two conditions: (a) delay under good weather conditions (referred to as Visual Flight Rules, or VFR), and (b) delay under cases of low visibility, inclement weather or other conditions requiring an increased spacing of takeoffs and landings (referred to as Instrument Flight Rules, or IFR). The delays will be greater under the latter conditions. For these, the probabilities of occurrence and the extent of delays can be calculated based on projected future traffic volumes from the FAA Terminal Area Forecasts, State or Regional Aviation System Plans, or Airport Master Plans and historic occurrence rates for conditions of diminished capacity.[7] The analyst can calculate delay using the matrix shown in Table 7.

[7] Generally these calculations are performed by a specialized consultant with expertise in airport capacity and delay analysis, and not by a benefit-cost analyst, although the benefit-cost analyst would need to know the right questions to ask and whether additional studies are needed. Recent ACRP and FAA reports listed in the references at the end of the Guidebook provide guidance on the subject.

Table 7: Breakdown of Airside Delay

Weather Conditions and Time Periods	VFR		IFR*	
	Percent Time	Total Pass x Avg. Delay	Percent Time	Total Pass x Avg. Delay
Peak Periods				
Off-Peak Periods				
TOTAL				

** At some airports it may be necessary to define multiple categories of IFR conditions, since delays may be significantly different under each IFR condition (e.g., delays may depend on the wind direction). To use Table 7 under these cases, the analyst should add the appropriate number of columns ("percent time" and "total passenger x average delay") to the right of the single IFR column shown and identify each IFR condition analyzed.*

The result of Step 3 should be a total measure of the annual passenger delay for a future design year in a build (with project) and no build (without project) case. The general formula for calculating total delay in a future year is:

Aggregate Annual Passenger Time Delay (in person-hours for each category of delay)
= Number of Passengers (forecast to be flowing through the airport annually)
** Average Delay per Passenger (for that corresponding category and year)*

The analyst should make this calculation separately for each of the ten time categories that are applicable to the project. If possible, this calculation should be repeated for peak and off-peak time periods.

Step 4: Calculate Value of Delay

The fourth step calculates the value of the delay estimated in the previous step. For each of the ten time categories, the analyst should select the corresponding unit value of delay shown earlier in Chapter 2, Table 1. Then, the value of the savings is calculated for each time category using the following general formula:

Annual Value of Passenger Time (dollars, for each trip segment category)
= Aggregate Annual Passenger Time Delay (person-hours, from the formula in Step 3)
** Unit Valuation of Time per Hour of Passenger Time Savings (from Table 1)*

This calculation should be carried out for each applicable trip segment category, and the results then summed over all applicable trip categories, using the worksheet shown in Table 8.

Table 8: Worksheet for Calculating Value of Enhanced Travel Time (Reduced Delay)

Time Category	Total Annual Person-Hours of Time Saved x Value per Hour of Time ($2013)		
	Base Case	Project Case	Difference
Terminal landside (Departure)			
Ground access time			
Terminal access time			
Check-in and security time			
Time to reach gate area			
Gate time			
Airside (Flight)			
Flight time			
Unexpected flight delay			
Terminal Landside (Arrival)			
Time to reach bag claim or exit			
Baggage claim wait time and exit			
Ground egress time			
GRAND TOTAL			

There are several caveats and additional notes regarding the use of this calculation worksheet. First, it may also be observed that the worksheet does not provide a separate line for valuing time savings associated with transfers between connecting flights. If an airport capital investment project affects connecting passengers, the time savings of those passengers may be valued using the unit value of time for flight time. The ACRP 03-19 research did not specifically estimate a value of time for connecting passengers, but assumed that travelers valued time spent making connections the same as time spent in flight. To the extent that travelers consider the total travel time from their origin airport to their destination airport in making trade-offs between the travel time of different flights itinerary options (particularly between nonstop and connecting flights) and the associated airfares, it seems reasonable that they might value the time spent making connections much the same as the time spent on the aircraft.

Second, it should be noted that the worksheet is set up for simplicity purposes without reference to trip purposes or peak/off-peak periods. However, it is recommended that the worksheet should actually be filled out separately for business and for non-business (leisure) travel, and the results then summed. This is preferred over use of the national composite because each airport actually has a unique mix of business and leisure travelers. Some airports are used almost entirely by leisure travelers while others have a much greater use by business travelers. Clearly, the national composite average is not appropriate for those situations. Therefore the analyst should use the composite trip purpose values only when no information on the business and leisure travel mix is available.

Besides having information on the business/leisure mix of travelers, some airports may also have information to establish a different trip purpose mix for peak and off-peak travel (which may refer to either times of day or seasons of the year). All available information on customer trip purposes (business and leisure travel mix) and peak/off-peak differences should be used, as appropriate, to calculate overall time values that are appropriate for the specific airport.

Finally, it should be noted that information regarding the income levels of travelers should be used when available. While not all airports have survey information regarding the income mix of travelers, this information can enable a more sophisticated and accurate value of time savings associated with airport improvement projects. The appropriate unit valuation for time savings by income group was shown earlier in Chapter 2, Table 2.

Step 5: Apply to Benefit-Cost Analysis

The fifth step is to apply the information from Step 4 in a benefit-cost calculation. It is preferable to calculate the value of travel time savings directly for each future year given the non-linearity in delays as traffic levels increase, as well as likely changes in the values of time as: (1) the reduction of delays affects the overall time a passenger spends at the airport; (2) the relative change spent at the mix of time categories (see Table 5, the Time Impact Mapping Matrix); and (3) possibly the composition of the traffic.

However, the value of total annual savings in passenger time calculated in the fourth step can also be shown for a single future year. To use this value in a benefit-cost analysis, it is necessary to transform the single value into a year-by-year time stream of values. This normally involves extrapolating for a number for years beyond the future year for which the value of travel time savings was derived, and interpolating the annual value of travel time savings for intermediate years until the year for which the annual value was derived.

For the forecasting to be realistic, the analyst should consider that bottleneck delays start to occur with passenger volumes well below the runway, terminal, or gate facility capacity[8], and increase progressively (and non-linearly) as passenger volumes approach or exceed (for short periods of time) the facility capacity. Thus a realistic projection of delay should account for these threshold effects.[9]

The software or spreadsheet typically used by the analyst for benefit-cost analysis will take the time stream of annual time saving values and calculate a net present value. It is assumed that all values are expressed in constant dollars (excluding the effect of inflation),

[8] While, depending on the circumstances at each airport, this effect can start to become significant at a ratio of passenger activity to capacity of around 80%.

[9] Bottlenecks for airport landside components may impede circulation in the airport and extend trip time, or affect the efficiency of other components. Airport circulation may affect terminal access time, check-in and security time, time to reach the gate, and time at baggage claim, as well as boarding time. These impacts, depending on where the bottleneck forms, will affect the total value of time expended and possibly more than one component of the airport terminal part of a trip.

and that the discount rate reflects the time value of money above inflation[10]. The results should go into a benefit-cost table as shown in Table 9. This example shows only the benefit-side of the table, but the cost-side should also be included. The results of this guidebook should all be reported in the row shaded and labeled as "passengers - time savings." Depending on the nature of the time savings, there may be some additional diversion of trips from other airports. (See the text box below for a brief discussion of trip diversion.)

Table 9: Typical Benefit-Cost Table for an Analysis

Component	Sum Across All Years		
	Undiscounted Value	Discounted Value	Net Present Value
Airline – Revenue Added*			
– Staff Time Cost Savings			
– Operating Expense Savings			
Airport – Revenue Added*			
– Staff Time Savings			
– Operating Expense Savings			
Passengers – Time Savings			
– Expense Savings			
Shifted Trips – Time Savings			
– Expense Savings			
Cargo Operators: Cost Savings			
Salvage Value of Asset			

** Changes in revenue are not typically included in benefit-cost analysis, since they are considered to be transfer payments, although they may be important for financial analysis.*

[10] The FAA mandates a seven percent discount rate in BCAs for Airport Improvement Program (AIP) discretionary grants greater than $10 million, and encourages sensitivity analysis with higher and lower discount rates (*FAA Airport Benefit-Cost Analysis Guidance*, Office of Aviation Policy & Plans, Federal Aviation Administration, December 15, 1999). There is much greater discretion available for airports and airport analysts in selecting discount rates for BCAs in capital decision making when not tied to the AIP grant process.

Assessing Trip Diversions and the Value of Time Savings

Trip diversion refers to passengers selecting a different airport to use as a result of an airport capital investment project or operational changes. Such diversions may occur if a capital investment improves air service and passenger convenience at one airport compared to other airports in the vicinity. Diverted trips arise from new or extended runway projects that enable airports to offer longer distance non-stop flights. In such cases, passengers in the affected markets beginning their trips closer to the airport that has attracted additional air service may opt for the shorter ground trip. For example, a passenger may have to drive 50 minutes to take a non-stop transcontinental flight from the closest airport that offers this service. But if an airport situated 15 minutes from the passenger's ground origin builds an 8,000 foot runway enabling transcontinental flights (and attracts an air carrier to provide this service) then the passenger may opt to change airports to save the 35 minutes (each way) in ground transportation. Stated preference or revealed preference techniques can be used along with an analysis of air passenger ground trip origins to estimate the volume of any diversion. The value of the time savings of diverted trips includes the difference between ground access time to the original airport and the time to the improved airport.

In other cases, trips may be attracted from other airports if a capital investment project allows more frequent flights to the same destination (installation of additional gates may be an example of this). Surveys of business travelers in multi-airport regions typically show that larger airports are preferred by business travelers over the geographical convenience of smaller but closer airports, since they generally provide more alternatives should a flight be canceled. In this case, there may be a tradeoff between the dis-benefit of longer ground access times with the advantages of more flight options at the larger airport and reduced risk of long delays due to canceled flights. In such situations, fairly

4 EXAMPLES ILLUSTRATING TIME VALUATION

To show how the five-step methodology and calculation process works in practice, three illustrative case studies have been developed. These cases are all drawn from real world examples of airport improvement projects, though they are not identified and the numbers have been altered to make them more generally applicable. Each affects a different set of trip segments. They are:

(A) Runway extension -- reducing passenger travel times by enabling new nonstop markets to be served;

(B) Ground access – reducing ground access and egress times and enhancing reliability (by constructing an automated people mover connection to a nearby rail station that replaces shuttle buses on a congested airport access road); and

(C) Navigation aid upgrade – reducing flight delays (by reducing flight cancellations and diversions due to inclement weather).

The second example also demonstrates the use of more detailed information on the income profile of passengers at a specific airport.

Example A: Runway Extension Project

In this example, a regional airport is proposing a runway extension that will facilitate new nonstop service to and from the airport. The project includes lengthening the main runway by 600 feet, adding complementary taxiway enhancements, acquiring right-of-way for the runway, and relocating local roads to accommodate the runway and an FAA-required runway safety area.

Currently, airlines operating from the airport provide nonstop service to five major airports. Extending the main runway would allow nonstop service in six additional major markets, as larger aircraft would be able to use the longer runway. Therefore, airlines would now find it feasible and profitable to operate nonstop service to these new destinations.

The main passenger benefit of the project is the time savings created by the new nonstop flights. There are also three other benefit categories: reductions in airline operating costs due to the airport's ability to accommodate larger aircraft and serve more markets, reduced incidence of aircraft weight penalties due to insufficient runway length, and increased passenger comfort. Since this guidebook does not address these other benefits, the example will focus on the travel time savings.

Step 1: Screen Project for Applicability. The analyst checks the project for suitability to use this guidebook by using the Project Screener table (Table 4). This runway extension project is an "airport (non-terminal) – airside" project. For many airports, the main benefit of a runway extension would be to reduce airline costs (and potentially airfares) by accommodating larger aircraft. However, in this case, the runway expansion is intended to enable new nonstop service, which will result in time savings to passengers.[11]

Step 2: Identify Relevant Time Categories. The runway extension project impacts the airport-to-airport flight time, which includes time spent for taxi, takeoff, and landing, in-flight time, and time spent at connecting airports. Specifically, the in-flight time and time spent at connecting airports will decline for passengers with an origin or destination at any of the six new nonstop markets.

Step 3: Calculate Travel Delay Change. The next step is to calculate the time savings. In this case, the time savings are a function of the number of passengers who utilize the new nonstop service. Currently, the airport has 520,000 outgoing passengers annually. Approximately 17.4 percent of passengers have a destination in one of the six new markets that will be served by nonstop service. Therefore, 90,480 passengers have a destination in one of the six new markets.

Assuming that there are also approximately 520,000 incoming passengers annually and that 17.4 percent of passengers landing at the airport had an origin in one of the six new markets, approximately 90,480 passengers have new nonstop access from one of the six new markets.

These markets are shown in Table A-1. Overall, approximately 180,960 passengers will now have access to nonstop service, either to or from the regional airport.

Currently, Markets A through F can be accessed only via connections at major airports. However, as a result of the runway extension and airlines now offering nonstop flights in each of these new markets, the project will result in time savings to passengers traveling to these markets. For example, in Market C, the current trip duration, including connections, is 4.3 hours. New service would cut the travel time to 2.3 hours, resulting in a 2-hour time saving per passenger. Table A-2 shows the travel times with and without the runway extension as well as the expected travel time savings.

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[11] The extent to which a runway extension would reduce delay by allowing the airlines to reduce the number of flights by using larger aircraft is a complex issue. Airlines compete on flight frequency, so even if they could reduce the number of flights, they might decide not to. However, even if relevant airlines reduced their number of flights, the passenger benefits of the reduced delay would have to be offset against the dis-benefits of less frequent flights.

Table A-1: Passenger Volume and Share of New Nonstop Service (Boardings & Alightings)

New Market	(1) Market Share of Total Passengers at Airport	(2) Number of Passenger Boardings Col. (1) x 520,000	(3) Number of Passenger Alightings Col. (1) x 520,000	(4) Total Number of Passengers Col. (2) + Col. (3)
A	6.3%	32,760	32,760	65,520
B	4.0%	20,800	20,800	41,600
C	2.9%	15,080	15,080	30,160
D	1.8%	9,360	9,360	18,720
E	1.3%	6,760	6,760	13,520
F	1.1%	5,720	5,720	11,440
Total	**17.4%**	**90,480**	**90,480**	**180,960**

Table A-2: Average Trip Lengths to New Nonstop Markets

New Market	(1) Avg. Connecting Trip Length (hour/trip)	(2) Avg. Nonstop Trip Length (hour/trip)	(3) Time Savings (hour/trip) Col. (2) – Col. (1)	(4) Market Share of Total Flights at Airport	(5) Weighted Time Savings (hour/passenger) Col. (3) x Col. (4) ÷ 17.4%
A	4.0	2.4	1.6	6.3%	.58
B	4.4	2.7	1.7	4.0%	.39
C	4.3	2.3	2.0	2.9%	.33
D	4.9	2.8	2.1	1.8%	.22
E	4.0	2.4	1.6	1.3%	.12
F	4.5	2.7	1.8	1.1%	.11
Total				**17.4%**	**1.75**

The time savings are weighted by the corresponding market share. Overall, nonstop trips to these markets are expected to reduce passenger travel time by 1.75 hours per passenger using the new flights. Since both time savings incurred in flight and in making connections are assumed to have the same value, there is no need to determine how much of the travel time savings result from shorter flight times and how much from the elimination of the connection.

Step 4: Calculate Value of Delay Reduction. As detailed in Step 2, the runway extension project creates passenger in-flight time savings. At this regional airport, passenger surveys have revealed that approximately 40 percent of passengers are business travelers, while the remaining 60 percent are leisure passengers. Information on the income distribution of passengers is not available.

As shown in Table 1 in chapter 2, business passengers have an in-flight value of time of $51.00 per hour, while leisure travelers have an in-flight value of time of $34.90 per hour[12]. To calculate a composite value of time, the analyst uses the following equation:

Composite Value of Time = Proportion of Business Travelers x Business Value of Time (VOT)
+ Proportion of Leisure Travelers x Leisure VOT

= (40% x $51.00) + (60% x $34.90)

= $41.34 / hour

To avoid overstating benefits, the analyst assumes that only 50 percent of passengers utilize the new nonstop service. In addition, the analyst assumes that the market shares of the new nonstop markets do not change as a result of the new nonstop service (i.e. the availability of the new nonstop service does not generate any new passenger trips). As a result, the following equation is used to calculate the monetized passenger time savings:

Passenger Time Savings = Total Number of Passengers in the Six New Nonstop Markets
x Proportion of Passengers Choosing Nonstop Service
x Average Time Savings per Flight per Passenger
x Composite Value of Time

= 180,960 passengers x 50% x 1.75 hours/passenger x $41.34/hour
= $6,560,823

Step 5: Apply to Benefit-Cost Analysis. To use this estimate in a benefit-cost analysis, the projection of the airport business plan is that the runway extension opens in 2015 and that new nonstop service in the six markets begins immediately. (Alternatively, service to new markets could be phased in.) The analyst also assumes that the mix of business and leisure passengers does not change as a result of the new nonstop service and that the total number of passengers departing from or arriving at the airport grows by 2 percent annually. The benefit-cost analysis covers a 22 year span, from 2013-2025. Significant costs, including land acquisition (if any), planning, engineering and construction occur before benefits begin to accumulate, and are assumed in the years 2013 and 2014. The first year of realizing benefits, 2015, is the third year of the BCA period.

Table A-3 presents the undiscounted and discounted benefits estimated over the 20-year benefit-analysis period. For the first 20 years of the project in operation, the runway extension is projected to deliver $112.9 million in passenger time savings when benefits are discounted at 3 percent and $75.5 million when discounted at seven percent. These benefits would be larger if a longer analysis period were chosen.

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[12] These are 2013 values of time (in 2013 dollars). If real incomes rise in the future, the values of time will increase as well. A discussion of updating the values of time is found in Chapter 5 of this guidebook.

As part of a comprehensive benefit-cost framework, the total passenger travel time savings can be added to other benefit categories, such as safety benefits or reductions in airline operating costs, and compared with capital and operating and maintenance (O&M) costs.

Table A-3: Annual Travel Time Savings of the Runway Extension, 2015 - 2034

Year	New Nonstop Passengers	Annual Travel Time Savings, 2013 $		
		Undiscounted	Discounted at 3%	Discounted at 7%
2015	90,480	$6,560,823	$6,184,205	$5,730,477
2016	92,290	$6,692,040	$6,124,164	$5,462,698
2017	94,135	$6,825,881	$6,064,707	$5,207,432
2018	96,018	$6,962,398	$6,005,826	$4,964,094
2019	97,938	$7,101,646	$5,947,517	$4,732,127
2020	99,897	$7,243,679	$5,889,774	$4,510,999
2021	101,895	$7,388,553	$5,832,592	$4,300,205
2022	103,933	$7,536,324	$5,775,965	$4,099,261
2023	106,012	$7,687,050	$5,719,887	$3,907,707
2024	108,132	$7,840,791	$5,664,354	$3,725,103
2025	110,295	$7,997,607	$5,609,361	$3,551,033
2026	112,501	$8,157,559	$5,554,901	$3,385,097
2027	114,751	$8,320,710	$5,500,970	$3,226,915
2028	117,046	$8,487,125	$5,447,562	$3,076,125
2029	119,386	$8,656,867	$5,394,673	$2,932,380
2030	121,774	$8,830,004	$5,342,298	$2,795,353
2031	124,210	$9,006,605	$5,290,431	$2,664,729
2032	126,694	$9,186,737	$5,239,068	$2,540,209
2033	129,228	$9,370,471	$5,188,203	$2,421,508
2034	131,812	$9,557,881	$5,137,832	$2,308,353
Total	**2,198,426**	**$159,410,751**	**$112,914,289**	**$75,541,805**

It can be seen from Table A-3 that the discount rate used can have a dramatic effect on the present value of the future travel time savings. While a higher discount rate will also reduce the present value of future costs, to the extent that capital costs for a project are typically incurred early in the project, the effect of higher discount rates on the present value of project costs will usually be much less than the effect on the present value of project benefits. Thus care is needed in the selection of an appropriate discount rate when not constrained by a mandated rate (such as the FAA's requirement of a 7% discount rate for discretionary AIP grant projects). While it is not uncommon to perform a sensitivity analysis with different discount rates (as shown in Table A-3), it should be recognized that this could well result in the present value of the benefits of a project exceeding the present value of project costs at a lower discount rate but not at a higher rate.

Example B: Ground Access Project

In this example, a metropolitan area transit system is proposing a rail connector system that links the existing rail transit service to a regional airport. Currently, direct shuttle bus service is provided between the nearest rail transit station and the airport. The project would replace the bus service with an Automated Guideway Transit (AGT) people mover, a driverless train service on an exclusive aerial guideway. The AGT would have termini at an existing rail transit station and the airport as well as two intermediate stations.

The project is intended to improve access to the airport using a grade-separated people-mover connection from the existing rail transit system, reduce travel time between the rail transit station and the airport, enhance reliability, and add capacity compared to the existing shuttle bus service.

The shuttle bus shares local roads with other traffic and is subject to traffic delays. Special events in the area can create major delays for the shuttle service. In contrast, the AGT would use an exclusive aerial guideway, eliminating the impacts of local traffic on travel time. Reliability of service times is particularly important to departing airport passengers; holding travel times equal between two alternatives, passengers tend to prefer alternatives with less variation in travel times.

When using the shuttle bus service, passengers must exit the rail transit station, purchase a shuttle bus ticket, and wait for the shuttle on the curb. This process takes about four minutes on average. Average headways for the shuttle bus service are 10 minutes, so the average passenger wait for the service is five minutes. However, there is a fair amount of variability in wait times. Field surveys of typical wait times indicated that passengers can wait at the shuttle bus stop from 1 - 26 minutes. The average one-way in-vehicle time from the shuttle bus stop to the airport is 11 minutes, but it can take as long as 25 minutes. The shuttle bus drops off passengers across the curbfront roadway from the airport terminal. The walk from the shuttle bus stop to the terminal is estimated to take 1.5 minutes.

The new AGT service would provide expedited travel. The platform transfer to the AGT connector would be located within the paid area of the rail transit station, eliminating the need to purchase an additional ticket within the station. Access to the AGT platform from the rail transit platform is estimated to take 3 minutes. Average headways for the AGT connector are planned to be 3.5 minutes, so the average passenger wait time will be 1.75 minutes. Including the two intermediate stops, the one-way travel time to the airport is projected to be 8.2 minutes. Additional ridership justifies the construction of these two intermediate stops, but this additional ridership is not included in the benefits for the airport passengers. The AGT station at the airport will be located in the parking facility across the curbfront roadway from the terminals. It is estimated that the walk time from the station to the terminal will be 3 minutes.

Step 1: Screen Project for Applicability. The first step in the process is to screen whether this guidebook is applicable to the project by using the Project Screener table (Table 4). The AGT connector project is an "airport (non-terminal) – groundside" project. The AGT connector has two components:

- The AGT connector provides a new access link to the airport; and
- The AGT connector provides a new transfer facility at the rail transit station.

Each of these components can have an impact on air passenger travel times. The new AGT service replaces the current shuttle bus service. Relative to the shuttle bus, the AGT will have shorter trip times, shorter wait times, more reliable trip times, more reliable wait times, and higher capacity. The new transfer facility at the rail transit station reduces transfer time relative to the current shuttle bus service because the transfer takes place within the paid area of the station and passengers no longer have to purchase a separate ticket for the shuttle bus after exiting the rail transit station.

However, the new AGT station at the airport will increase the time it takes to walk to the terminal compared to the current shuttle bus service.

Step 2: Identify Relevant Time Categories. The rail connector project impacts two of the seven time categories:

- *Ground Access Time:* The travel time from a person's origin location to their transit stop/station at the airport; and
- *Terminal Access Time:* The time to reach the airport terminal from the transit stop/station at the airport.

Step 3: Calculate Travel Delay Change. The next step is to calculate the time savings by comparing travel times for the AGT service and the existing shuttle bus service. These calculations are shown in Table B-1.

Table B-1: Average Trip Time under AGT and Shuttle Bus Service

Time Category	Alternative 1: AGT Rail Connector	Alternative 2: Shuttle Bus
Average Exit and Wait Time	4.75 minutes	9 minutes
Average In-Vehicle Time	8.2 minutes	11 minutes
Average Time to Access Terminal	3 minutes	1.5 minutes
Average Total Trip Duration	**15.95 minutes**	**21.5 minutes**

The Exit and Wait category measures the time between exiting the rail transit vehicle and entering the shuttle bus or AGT connector. It consists of the time needed to exit the station plus the average headway for each mode. The average In-Vehicle Time is the trip duration on the shuttle bus or AGT, while the average Time to Access Terminal measures the length of time it takes to walk to the terminal building entry from the point where the connector service drops off passengers.

The reduction in travel delay can be estimated by comparing the two columns in Table B-1. On average, Alternative 1 saves 5.55 minutes per trip versus Alternative 2. Alternative 1 saves 7.05 minutes in airport ground access time (first two rows) and adds an additional 1.5 minutes in terminal access time (last row).

Step 4: Calculate Value of Delay Reduction. Currently, about 50 percent of passengers at the airport travel for business, while the remaining 50 percent travel for leisure. The AGT is expected to open in 2020 and have an annual ridership of five million passengers. As a result, there will be 2.5 million leisure passengers and 2.5 million business passengers who utilize the AGT in 2020.

The guidebook presents segmented value of time estimates for business and leisure passengers by income levels, which will be used for this example. Based on the findings of an air passenger survey performed at the airport, 40 percent of business passengers earned less than $75,000 annually in 2013, 30 percent earned between $75,000 and $199,999, and 30 percent earned $200,000 or more annually. For leisure passengers, 50 percent earned less than $75,000 annually in 2013, 25 percent earned between $75,000 and $199,999, and 25 percent earned $200,000 or more annually. The number of passengers by income level is shown in Table B-2.

Table B-2: Number of Passengers by Income Level

Income Level (2013)	Business		Leisure	
	(1)	(2)	(3)	(4)
	Percent	Passengers Col. (1) x 2.5 M	Percent	Passengers Col. (3) x 2.5 M
Less than $75,000	45%	1,125,000	55%	1,375,000
$75,000 - $199,999	35%	875,000	30%	750,000
$200,000 and More	20%	500,000	15%	375,000

Using this information, the analyst determines the value of time for these passengers using the information found in Table 6 of the guidebook. The relevant values for ground access time and terminal access time are summarized in Table B-3.

Table B-3: Passenger Values of Time by Income for Ground Access and Terminal Access Time (in 2013 $)

Component	Individual Income		
	Less than $75,000	$75,00 - $199,999	$200,000 and More
Business Travelers			
Ground access time	$13.90	$21.32	$38.49
Terminal access time	$23.75	$36.35	$65.65
Leisure Travelers			
Ground access time	$14.55	$16.65	$22.15
Terminal access time	$22.10	$25.20	$33.60

The aggregate annual ground access time savings for business and leisure passengers will be calculated using the 7.05 minutes of ground access time saved per trip estimated in Step 3. In 2020, passengers will save a total of 587,500 hours by utilizing the AGT. This has a monetized value of over $11.1 million. These calculations are presented in Table B-4.

Table B-4: Ground Access Time Savings from the AGT Project (in 2020, in 2013 $)

Income Level	(1)	(2)	(3)	(4)
	Number of Annual Passengers	Ground Access		
		Savings in Hours Col. (1) x 7.05 ÷ 60	Value of Time ($/hour)	Savings in Dollars Col. (2) x Col. (3)
Business Travelers				
Less than $75,000	1,125,000	132,188	$13.90	$1,837,406
$75,000 - $199,999	875,000	102,813	$21.32	$2,191,963
$200,000 and More	500,000	58,750	$38.49	$2,261,288
Leisure Travelers				
Less than $75,000	1,375,000	161,563	$14.55	$2,350,734
$75,000 - $199,999	750,000	88,125	$16.65	$1,467,281
$200,000 and More	375,000	44,063	$22.15	$975,984
Total	**5,000,000**	**587,500**		**$11,084,656**

Table B-5 shows the comparable calculations for the increase in terminal access time. Recall from Step 3 that the AGT adds an additional 1.5 minutes of terminal access time per trip.

Table B-5: Terminal Access Time Savings from the AGT Project (in 2020, in 2013 $)

Income Level (2013)	(1) Number of Annual Passengers	(2) Terminal Access Time: Additional Travel Time in Hours Col. (1) x 1.5 ÷ 60	(3) Terminal Access Time: Value of Time ($/hour)	(4) Terminal Access Time: Value of Additional Travel Time in Dollars Col. (2) x Col. (3)
Business Travelers				
Less than $75,000	1,125,000	28,125	$23.75	$667,969
$75,000 - $199,999	875,000	21,875	$36.35	$795,156
$200,000 and More	500,000	12,500	$65.65	$820,625
Leisure Travelers				
Less than $75,000	1,375,000	34,375	$22.10	$759,688
$75,000 - $199,000	750,000	18,750	$25.20	$472,500
$200,000 and More	375,000	9,375	$33.60	$315,000
Total	**5,000,000**	**125,000**		**$3,830,938**

As a result, the AGT project is projected to save business and leisure travelers:

587,500 – 125,000 = 462,500 person-hours in 2020, valued at

$11,084,656 - $3,830,938 = $7,253,719 (in 2013 $).

Step 5: Apply to Benefit-Cost Analysis. To use this figure in a lifecycle benefit-cost analysis, the analyst estimates annual travel time benefits over a 20-year period from 2020 to 2039, following three years of planning, engineering and construction from 2017-2019. The AGT service is expected to open in 2020 (the fourth year of the benefit-cost analysis) and AGT ridership is expected to grow at five percent per year. The analyst assumes that the mix of business and leisure passengers as well as their income distribution does not change over time. Table B-6 presents the undiscounted and discounted benefits over the 20-year analysis period. Undiscounted benefits are highest in 2039 due to the passenger growth rate, with an estimated benefit of more than $18.3 million. Over the first 20 years of the project, the AGT connector is projected to deliver $160.4 million in passenger time savings when benefits are discounted at three percent and $99.6 million when discounted at seven percent.

Table B-6: Annual Travel Time Savings of the AGT Connector Service, 2020 - 2039

Year	Number of Passengers	Annual Travel Time Savings, in 2013 $: Undiscounted	Annual Travel Time Savings, in 2013 $: Discounted at 3%	Annual Travel Time Savings, in 2013 $: Discounted at 7%

Year	Number of Passengers	Annual Travel Time Savings, in 2013 $		
		Undiscounted	Discounted at 3%	Discounted at 7%
2020	5,000,000	$7,253,719	$6,638,180	$5,921,195
2021	5,250,000	$7,616,405	$6,767,077	$5,810,519
2022	5,512,500	$7,997,225	$6,898,476	$5,701,911
2023	5,788,125	$8,397,086	$7,032,427	$5,595,333
2024	6,077,531	$8,816,940	$7,168,979	$5,490,747
2025	6,381,408	$9,257,788	$7,308,183	$5,388,117
2026	6,700,478	$9,720,677	$7,450,089	$5,287,404
2027	7,035,502	$10,206,711	$7,594,751	$5,188,574
2028	7,387,277	$10,717,046	$7,742,222	$5,091,591
2029	7,756,641	$11,252,899	$7,892,557	$4,996,422
2030	8,144,473	$11,815,543	$8,045,810	$4,903,030
2031	8,551,697	$12,406,321	$8,202,040	$4,811,385
2032	8,979,282	$13,026,637	$8,361,302	$4,721,453
2033	9,428,246	$13,677,969	$8,523,658	$4,633,201
2034	9,899,658	$14,361,867	$8,689,166	$4,546,599
2035	10,394,641	$15,079,960	$8,857,887	$4,461,616
2036	10,914,373	$15,833,958	$9,029,885	$4,378,221
2037	11,460,092	$16,625,656	$9,205,223	$4,296,386
2038	12,033,096	$17,456,939	$9,383,965	$4,216,079
2039	12,634,751	$18,329,786	$9,566,178	$4,137,274
Total	**165,329,771**	**$239,851,131**	**$160,358,057**	**$99,577,058**

As part of a comprehensive benefit-cost framework, the total passenger travel time savings can be added to other benefit categories, such as safety or emissions benefits, and compared with capital and O&M costs.

Example C: Navigation Aid Upgrade Project

In this example, a regional airport is proposing to upgrade an existing instrument landing system (ILS) from Category I to Category III. An instrument landing system is a radio navigation system that emits signals that provide both lateral and vertical guidance to aircraft during approach and landing on a runway. A Category III ILS installation requires more extensive approach and runway lighting than a Category I system.

This regional airport regularly experiences weather conditions that obscure visibility to low levels. In fall and winter months, ground fog and snow are common. A Category III ILS would allow planes to land under lower visibility conditions than currently possible using the existing Category I ILS.

For an aircraft to land on a runway using Category I ILS, visibility must be at least 0.5 mile and the decision height must be at least 200 feet. Decision height is defined as the lowest height at which the pilot must initiate a missed approach if the runway is not visible. Missed approaches require the aircraft to climb clear of the airport and restart the landing process. Runway visual range (RVR) must be at least 2,400 feet.

There is no visibility minimum for aircraft to land on runways using Category III ILS. Depending on the level of Category III – IIIa or IIIb – the decision height ranges from 0 to 100 feet. The required RVR ranges from 250 to 660 feet.

The navigational aid project is intended to reduce the incidence of flight cancellations and delays. Ten years of historical weather data indicate that hours when weather conditions are below Category I ILS minimums but above Category III ILS minimums affect 1.4 percent of the arriving flights at the airport. Historical data on flight operations indicate what happens to flights scheduled during poor weather conditions. When weather is below the Category I ILS minimums, flights are cancelled or diverted 55 percent of the time, while they are delayed 45 percent of the time.

Step C-1: Screen Project for Applicability. The first step in the process is to screen the project to see whether this guidebook is applicable to the project. According to the Project Screener table (Table 4), the navigation aid project falls under the "airport (non-terminal) – airside" category. The project involves an upgrade of air traffic control equipment, which should reduce air delay.

Step 2: Identify Relevant Time Categories. The navigation aid project impacts the flight delay, which is defined as unanticipated delay in the airport-to-airport flight time experienced by passengers.

Step 3: Calculate Travel Delay Change. The next step is to calculate the time savings from the reduced incidence of delay. For this airport, analysis of data on flight delays in recent years showed that flights delayed due to poor weather resulted in passenger delays of 1.75 hours on average. Flights cancelled or diverted due to poor weather result in larger passenger delays, 3.5 hours on average. Data on delayed, diverted, or cancelled flights are available for each airport from the USDOT Airline On-Time Performance database (at http://transtats.bts.gov). Calculating the average passenger delay for diverted or cancelled flights requires an analysis of the subsequent arrival time of a diverted flight or the arrival times of the subsequent flights that did arrive in the case of cancelled flights. However, depending on the load factor on the next flights that do arrive and the number of cancelled flights, passengers on cancelled flights may have to wait through several subsequent flights before there is one with available space.

With 400,000 annual passenger enplanements at this airport, the number of passengers expected to be impacted by the upgrade in ILS from Category I to Category III is calculated to be:

400,000 * 1.4% = 5,600 passenger per year

Table C-1 shows the total annual time savings from the navigational aid upgrade. The new navigational aid is expected to save a total of 15,190 hours of passenger time per year.

Table C-1: Total Annual Time Savings from Navigational Aid

Flight Impact	(1) Proportion (%)	(2) Average Delay (hours)	(3) Annual Time Savings(hours) Col. (1) x Col. (2) x 5600
Delayed	45%	1.75	4,410
Cancelled or Diverted	55%	3.5	10,780
Total			**15,190**

Step 4: Calculate Value of Delay Reduction. A passenger survey indicates that approximately 35 percent of travel is for business while 65 percent is for leisure at this airport. There is no information on passenger income distribution. The most recent 12 month spread of airport data show that 79 percent of all flights are on time, 10% of flights are delayed for reasons having unrelated to visibility conditions, and 11 percent of flights are delayed due to weather conditions and poor visibility with an average delay 99 minutes per flight.

Table 1 of this guidebook shows that business travelers have a value of time of $286.30 per hour for flight delays, while leisure travelers have a value of time for flight delays of $123.30 per hour. To calculate the composite value of time, the following equations are used:

Expected Delayed Minutes = Proportion of Delayed Flights x Average Minutes of Delay

*= .11 * 99 = 10.92 minutes*

*Composite Value of Time = Hourly Equivalency of Expected Delayed Minutes * ((Proportion of Business Travelers x Business Value of Time (VOT) + (Proportion of Leisure Travelers x Leisure VOT))*

=10.92/60((35% * $286.30) + (65% x $123.30)) = $32.82/ hour*

The analyst then uses the following equation to calculate monetized passenger time savings:

Passenger Time Savings = Total Hours of Delay Avoided by Navigation Aid Upgrade x Composite Value of Time

= 15,190 hours x $32.82 / hour = $498,592 per year

Step 5: Apply to Benefit-Cost Analysis. To use this estimate in a benefit-cost analysis, the analyst assumes that the navigational upgrade will be purchased in 2014 and operational in 2015 (year 2 of the BCA), and that the airport experiences reduced delays immediately. The analyst also assumes that the mix of business and leisure passengers does not change and that the total number of passengers departing from or arriving at the airport grows by 2.5 percent annually. The benefit-cost analysis covers a 20-year analysis period, so it includes annual travel time benefits from 2015 to 2034.

Table C-2 presents the undiscounted and discounted benefits estimated over the 20-year analysis period. For the first 20 years of the project, the navigational aid upgrade is projected to deliver $50.8 million in passenger time savings when benefits are discounted at three percent and $35.1 million when discounted at seven percent.

As part of a comprehensive benefit-cost framework, the total passenger travel time savings can be added to other benefit categories, such as safety benefits, and compared with capital and operating and maintenance (O&M) costs.

Table C-2: Annual Travel Time Savings of the Navigational Aid Upgrade, 2015 - 2034

Year	Hours of Delay Saved	Annual Travel Time Savings, in 2013 $		
		Undiscounted	Discounted at 3%	Discounted at 7%
2015	15,190	$498,592	$484,070	$465,974
2016	15,570	$511,057	$481,720	$446,377
2017	15,959	$523,833	$479,382	$427,604
2018	16,358	$536,929	$477,055	$409,621
2019	16,767	$550,352	$474,739	$392,394
2020	17,186	$564,111	$472,434	$375,891
2021	17,616	$578,214	$470,141	$360,083
2022	18,056	$592,669	$467,859	$344,939
2023	18,508	$607,486	$465,587	$330,432
2024	18,970	$622,673	$463,327	$316,535
2025	19,444	$638,240	$461,078	$303,223
2026	19,931	$654,196	$458,840	$290,471
2027	20,429	$670,551	$456,612	$278,255
2028	20,940	$687,315	$454,396	$266,552
2029	21,463	$704,497	$452,190	$255,342
2030	22,000	$722,110	$449,995	$244,604
2031	22,550	$740,163	$447,811	$234,317
2032	23,113	$758,667	$445,637	$224,462
2033	23,691	$777,633	$443,473	$215,022
2034	24,283	$797,074	$441,321	$205,979
Total	**388,023**	**$12,736,362**	**$9,247,666**	**$6,388,076**

5 CONCLUSIONS AND RECOMMENDATIONS

Importance of Segmentation. The concept of having a different value of time for different segments of a trip is far from new. For instance, public transportation planners have long recognized that transit riders place a premium on saving “out of vehicle” travel time (associated with walking to and waiting at a bus stop), compared to the value of saving “in vehicle” travel time (riding the bus). The application of similar segmentation is particularly useful for the complex airport experience, which has multiple distinct stages. By segmenting airline travel into component parts, it thus becomes possible to represent differences in comfort, amenity, work efficiency, passenger familiarity and travel time reliability that are associated with those different trip elements. The segmentation specifically makes it possible to represent the effects of implementing technology changes that affect the terminal access, check-in, security, gate access and gate waiting experiences of passengers. It also makes it possible to consider ways to optimize the user experience by recognizing that some segments of the traveler experience are more onerous than others.

Uses of the Segmented User Benefit Methodology. This analysis approach has several distinct uses. It can help *airport planning and design* by recognizing and considering ways to optimize airport enhancement plans -- via changes that affect passenger throughput capacity, passenger quality of experience, reliability of processing times, and passenger movement within airport terminal buildings. It can also help *prioritize project funding decisions* by giving greater weight to projects that travelers value the most. And finally, it can help *investment decision-making* by more accurately representing user benefits within benefit-cost analysis calculations.

One of the most important aspects of this approach is that it calls attention to airport terminal design and operational elements as important subjects for time analysis and benefit-cost calculations. To date, the majority of FAA Airport Improvement Program grant funds awarded focus on airside enhancements – particularly runway, airfield lighting, and navigation aid investments that enable greater airside capacity, use of larger aircraft, and faster and more reliable travel between cities. Airport terminal building enhancements may be funded in part or completely by state, local or independent agencies that own the facility, and hence may not be subject to the same level of benefit-cost analysis. Yet this guide shows that it is indeed possible and advantageous to consider air passenger airport terminal and ground access times as well as aircraft flight times, and thus measure the full air traveler experience, from ultimate origin to ultimate destination.

Still, not every proposed airport improvement requires a detailed analysis of all trip elements experienced by passengers. Accordingly, the use of a screening process is important, as it allows the recommended methodology to be used only in cases where the effort to assemble and apply the necessary additional data is indeed worthwhile.

Updating. Finally, it is important to note that the values of traveler time will change over time in response to changes in income levels. Just as wage rates change over time, so too will the "stated preference" valuation of time savings for air travelers. These changes will reflect two interrelated effects. First, values of time expressed in current dollars will change reflecting the rate of inflation. However, expressing the values of time in constant dollars (i.e. correcting for inflation) will eliminate this effect. Secondly, to the extent that values of time are a function of the income level of the traveler, values of time expressed in constant dollars will change in response to changes in real incomes (i.e. incomes expressed in constant dollars). If real incomes rise, then the values of time in constant dollars will also rise. All of the currently recommended values of time (shown in Chapter 2, Tables 1 and 2) are expressed in 2013 dollars. To adjust these values for future changes in real incomes, they should be updated by the annual percent change in personal income, expressed in constant dollars. This can be approximated by using the median income for all US households (by state), as reported annually in the US Census Bureau's "Table H-8." This is the same source that is also used to update the values of time in the USDOT guidance on the value of time.

Note that there are potentially three steps to update the values of time. The first is to adjust the values for any changes in real incomes between 2013 and the current year, expressed in constant 2013 dollars. The second step is to project the change in the values of time for each future year of the analysis period based on the expected future change in real incomes from the current year, still expressed in constant 2013 dollars. The third step (which may not be necessary) is to convert those values of time in 2013 dollars to constant dollars in some other year (e.g. constant 2015 dollars). This is done by simply multiplying the values of time by the actual or projected inflation (typically determined from the change in the Consumer Price Index) from 2013 to the year in question.

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