TRB 16-4101 MEASURING AIR CARRIER PASSENGERS VALUES OF TIME BY TRIP COMPONENT

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ABSTRACT

This paper investigates how the value of airline passenger time varies by trip component, and how the calculation of value of time can be related to capital investments specific to each component. Travel time is often a significant consideration in benefit-cost analysis for airport projects. The empirical results reported here are based on a stated preference survey and subsequent model estimation. The survey used two separate conjoint exercises – one related to airport ground access and in-airport time components, and a second covering attributes related to the flight itinerary. We found that values of time differ by trip segment and trip purpose of travelers.

Keywords: Value of Time, Benefit-cost Analysis, Air Travel, Perceived Utility, Willingness-To-Pay

INTRODUCTION

Passenger value of time (PVT) is a major component of benefit-cost analysis (BCA) at commercial airports, and is used in the evaluation of projects that promise travel speed improvements or travel delay reductions. PVT may also apply to projects that will enable airlines to offer improved air service that will allow travelers to use a closer airport, a faster or more frequent service, or a service with fewer connections or less time spent in changing modes from surface transportation to air travel. PVT may also apply to projects that will provide faster circulation within an airport, including improved efficiency of security screening, reduced time required for proceeding from security screening to gates, or less time spent between connecting flights.

Historically, Federal Aviation Administration (FAA) guidance for the passenger value of time to be used in an airport BCA has conformed to U.S. Department of Transportation (DOT) guidance that provides single values for business travelers and personal travelers—and a third value ("all purposes"), which is a hybrid of business and personal travelers. The most recent values for air and high speed rail travel are $32.60 for personal travelers, $60.00 for business travelers, and $43.70 for all purposes. These values are also expressed as plausible ranges, shown in Table 1 (*1*).

TABLE 1 U.S. DOT Guidance on Passenger Value of Time by Trip Purpose

	Recommended	Plausible Range	
Trip Purpose	**Values**	**Low**	**High**
Business	$60.00	$48.00	$72.00
Personal	$32.60	$28.00	$41.90
All Purposes	$43.70	$36.10	$54.10

Source: *(1)*

Whether as ranges or as single values, these values do not take into account differences in travelers' willingness to pay (WTP) for time savings in segments of an air trip that are more or less onerous than others. The time spent in air travel involves many distinct travel segments, each involving time that might be made shorter or longer by actions taken by air carriers or terminal operators and each, potentially, valued differently by travelers. The air trip segments for which different types of projects or policies might affect travel times and for which travelers might have different values include:

- Ground access time to the airport
- Access to the terminal from parking, drop-off location, or transit stop
- Time spent in flight check-in and security
- Time walking or riding to gate area
- Time spent in the gate area before boarding the flight
- In-aircraft time, distinguishing between scheduled flight time and flight delay
- Transfer time to make flight connections
- Time walking or riding to baggage claim or terminal exit
- Baggage pickup and terminal egress time
- Ground egress time from the airport to final destination

Research undertaken as part of Airport Cooperative Research Program (ACRP) Project 03-19 *(2)*, explored how air travelers perceive differences in the value of time spent in each of these components. The overarching purpose of this research was to develop measures of air

passenger value of time for benefit-cost analyses that relate the segmentation of passengers' air trips to the different types of capital improvements that affect the disutility of each segment. In this way, airport sponsors, managers, and funding agencies can incorporate an appropriate passenger value of time for specific facility investments when deciding between projects. Cross-references of capital investment categories with the various components of air passenger time during an air trip are illustrated by Figure 1. Volume 1 of the report on the research project, ACRP Web-Only Document 22 *(2)*, includes a discussion of tools and methods for applying the refined assessment of passenger time valuation.

THEORY OF VALUE OF TIME

The most prominent approach to the value of time relies on a series of models (each successively more complete) by Becker *(3)*, Oort *(4)*, and DeSerpa *(5)*, with further extensions by Jara-Díaz *(6, 7)*, De Borger and Van Dender *(8)*, and De Borger and Fosgerau *(9)*. Convenient unified expositions are contained in Jara-Díaz *(10)* and Small and Verhoef *(11)*. Small and Verhoef also develop a mathematical theory of how travelers would value reliability of travel, the latter based especially on Noland and Small *(12)* and Bates et al. *(13)*.

The basic theory of valuation of travel time begins with a traveler who values purchased goods, time spent working, and time spent in several other specific activities, including leisure pursuits and various phases of travel. The traveler faces a budget constraint: goods must be purchased out of unearned plus earned income. Also, the traveler, or the household to which he or she belongs, faces an overall time constraint: total time available for work, travel, and other activities is limited. Finally, each travel activity requires a minimum amount of time determined by the nature of the transportation system. The objective is to determine how much the traveler would be willing to pay for a reduction in one of the required travel times which might occur, for example, due to a terminal upgrade at an airport. Implications of this theory include:

- *The value of time can be expected, on average, to rise with the wage rates of the traveler or of other members of the traveler's household.* If, as is common, the available measure is household income rather than the wage rate, the value of time is likely to rise with income. However, there is no presumption that this relationship should be proportional.
- *The value of time in any particular travel activity depends on factors that determine how much that time is enjoyed.* Travelers will value time savings more in onerous travel situations than in situations where they are relaxed and happy, because they want to reduce the amount of time they spend unpleasantly. This further implies:
    - *The value of time is strongly influenced by environmental conditions, by opportunities for productive activity, and by stress-inducing aspects of travel.* Examples of environmental conditions are noise, discomfort, and physical exertion. Examples of productive opportunities are use of electronics. Examples of stress-inducing aspects are lack of safety (perceived or actual), worry about missing connections, unfamiliarity leading to fear of making wrong choices, and high levels of crowding, to name but a few.

	Capital Investment	Passenger Air Trip Related Activity									
		Ground Access	Terminal Access	Check in & Security	Reach Gate	At Gate	Flight Time	Flight Delay	To Baggage Claim or Exit*	Baggage Claim*	Ground Egress*
Terminal Landside	Passenger Check-in			X							
	Passenger Screening (TSA)			X							
	People Mover to Gate				X						X
	Aircraft Gates					X					
	People Mover from Gate						X	X	X		
Airside	Baggage Handling									X	
	Air Traffic Control						X	X			
	Runway					X	X	X			
	Taxiways						X	X			
	Apron Area, Taxi lanes & Aircraft Gate Positions						X	X			
Groundside	Access Road to Airport	X									
	People Mover Access to Airport Terminal (from Transit, Rental Car or Parking Facilities)		X								X
	Parking Lot/Garage		X								X
	Central Bus or Train Transfer Facility to/from Airport Terminal		X								
	Airport Circulation Improvements for Taxis		X								
	Drop-off & Pickup Areas by Terminal Curb front		X								

FIGURE 1 Capital Facilities that Affect the Time Spent in Specific Air Passenger Activities

Note: Asterisks (*) denotes trip components that were omitted from the SP Survey in order to keep the survey at a manageable size for respondents.

- *The value of time can be affected by reliability.* Travelers face varying penalties or inconveniences if their schedules are disrupted by unanticipated delays. The more unpredictable are such delays, the more travelers will schedule extra time as a safety margin, and the more likely they will actually experience mild or severe inconvenience. Thus, they will also pay a premium to reduce the uncertainty of any particular component of travel time, the amount depending on how that component affects their likelihood of delays. For example, they will probably place a higher value on reducing components that precede a connecting flight than components at the end of their trip.

Recent Empirical Studies of Air Traveler Values of Time

As described in Hess et al. *(14)*, significant challenges are present in using data that describe air travelers' chosen itineraries alone to estimate values of time. In particular, it is difficult to infer what fares and other itineraries are available to travelers when they make their choices; thus, determining their time/cost trade-off is correspondingly difficult. Work based on such data is traditionally marred by problems with identifying significant and meaningful parameters values, notably for the cost coefficient (e.g., Pels et al. *(15, 16)*; Hess & Polak, *(17-19)*). In addition, it is difficult to determine the effects of travel time components other than flight time without having information about the details of those components. As a result, more recent work uses data from air passenger surveys which include both information about past trips made by the travelers and stated preference (SP) data describing how they might make those trips under changed circumstances.

Evidence in the literature suggests that data from SP surveys can be used to produce reliable measures of monetary valuations for different service attributes *(20)*. In particular, regular air travelers are accustomed to making complex choices, reducing any detrimental impacts of the hypothetical setting of SP surveys. Further steps can be taken to mitigate presentational effects by designing an SP survey to mimic a typical online booking system *(21)*. This study is also of interest given its in-depth study of the valuations of in-flight amenities, which show very high valuations on long-haul flights for better entertainment systems and greater seat pitch.

The studies conducted to date distinguish between values of ground access/egress times, flight times, connection times and flight reliability, but not specifically for the times to check in and clear security, nor for the initial wait time at the origin airport. Using data from a survey designed to collect information about actual trips made by air travelers combined with stated preference data, Adler et al. *(22)* found that air travelers' values of access/egress and flight time, as well as flight reliability, exhibited considerable heterogeneity across the population of travelers. They represented flight reliability by using the U.S. Department of Transportation's on-time performance metric (percentage of flights arriving no more than 15 minutes late), which is convenient because it is readily available to air travelers for most flights at the time of booking. The study accounted for random differences in preferences among travelers and found the value of flight time to be approximately $70 per hour for business travelers and about half that for non-business travelers. The value of access/egress time was only about 10-15% less than flight time, for both business and non-business travelers. The value of reliability was found to be $38 per 10 percentage point change in on-time performance for business travelers, but only $7 per 10 percentage point change for non-business travelers (with a high degree of heterogeneity for the latter). These results were broadly confirmed by Hess et al. *(14)*, with the additional

finding that for holiday travelers, the sensitivity to on-time performance increases with flight distance.

A subsequent study *(23)* using the same survey data as Adler et al. *(22)*, identified the key traveler characteristics, both demographic and trip-related, that cause systematic differences in values of time across the population. In addition to trip purpose (business vs. non-business), these factors include income, travel party composition, fare reimbursement, and duration at the destination, among others.

Finally, work by Hess and Adler *(24)* shows how values of time compare across four surveys that were conducted over a 5-year period. This work suggests that values of air travel time have changed over this period, likely as a result of such factors as changes in the composition of air travelers and changes in airport and in-flight amenities, some of which can be forecast and some of which may be difficult to anticipate. An implication of this finding is that values of time need to be periodically updated.

Valuation of Individual Components of Time in Air Travel

Air travel involves many distinct travel segments, each involving time that might be made shorter or longer by actions taken by air carriers or terminal operators. Given the theory developed above, some likely differences across these components in the values of time and reliability can be identified. Equally important, factors that affect those values can also be identified.

Component 1: Ground Access Time.

For ground access, the extensive theoretical and empirical literature on the values of urban travel time and its reliability is relevant. This is especially true for the literature on journey to work and other work trips because they, like travel to an airport, potentially involve a target (preferred) arrival time and substantial perceived costs of missing this target. One difference, however, is that the penalty for lateness is likely to be even higher for air travel (due to a missed flight) than for journey to work or other work trips (being late for work, a meeting or appointment). Unreliability, as perceived by the traveler, may be especially high on the airport access component of a return air trip from an airport in an unfamiliar city. It is also possible that the perceived costs of ground access delay will be higher for travelers making a trip involving connecting flights that for travelers taking a non-stop flight, although the authors are not aware of research studies on this topic. Lack of knowledge of the public transit system or of the typical patterns of highway congestion may add substantially to the riders allocating extra time for ground transportation.

Component 2: Terminal Access Time

The time spent getting to the terminal after arrival at the airport varies by ground access mode (component 1) and airport size. For example, a passenger dropped off at the terminal curb would use very little time in entering the facility. However, parking lots vary by distance (and price) from the terminal. Use of rail transit may require a bus or people mover ride from the airport stop, while an airport bus may bring passengers to the terminal curb.

Component 3: Time Spent in Flight Check-In, Security

This portion of the trip potentially involves high stress due to uncertainty and unfamiliarity with the physical layout and with required procedures. For example, travelers cannot know ahead of time the length of various queues for check-in (particularly if they need to obtain a boarding pass

from an agent, check bags, or otherwise interact with an airline representative) and to pass security screening. Furthermore, there is only limited opportunity to use this time productively, and the environment is often noisy and crowded. Thus, this component of time is likely to have a high value (i.e. travelers would pay a lot to reduce it); and this value depends strongly on a traveler's situation, experience with air travel, and reaction to stress. Furthermore, this part of the trip can contribute a lot to overall travel time uncertainty, making it a natural target for policies or investments designed to reduce uncertainty.

Component 4: Walking or Riding to Gate.
After clearing security, passengers still need to arrive at their gate for their flight. The level of stress associated with this component is related to how much time is available prior to boarding after clearing security and the length of the walk or ride to reach the gate – the time required may range from a few minutes to a lengthy walk or using a people mover.

Component 5: Gate Area Time.
Time spent at the gate, including patronizing nearby services, is probably the main use of any buffer time that was allowed and not lost through unexpected delays in the previous components of the trip. If this experience is relatively pleasant, it will reduce the overall cost of unreliability of the entire trip, by encouraging larger buffer times. For example, people may reduce the chance of missing their flight by planning to arrive in time for a leisurely meal, then adjust their plans to a more hurried or carry-on meal if they are delayed during ground access or flight check-in and security. Hence, investments in improving the environment for this part of the trip, or in making it more productive through mobile communications technology, may have an especially high payoff.

Component 6: In-Aircraft Time.
Time spent in the aircraft will be valued based on multiple factors—including dependence on trip purpose and income. The value will be less when conditions are more pleasant; those conditions depend on load factors, seat spacing, temperature, noise level, quality of cabin service, in-flight entertainment, and the like. Many of these factors will be functions of the airline and type of aircraft used for the flight. For purposes of how travelers perceive the disutility of in-aircraft time, the most important parts of in-aircraft time are probably dwell time at the gate (after boarding) and delays on the taxiway system before reaching the runway, which may be extra onerous due to limited personal mobility and associated discomfort, restricted use of electronic carry-ons, and not being sure when the plane will take off.

Component 7: Transfer Connection Time.
For connecting flights, the time spent deplaning and walking or riding to the departure gate has similar characteristics to walking or riding from security screening to the gate at the departure airport (component 4 above), in that both activities require some walking within the airport terminal. The penalty for lateness on the inbound flight may be even greater than in the case of a non-stop flight—missing a connection usually means the potential of several hours additional delay or even an unplanned overnight stay at the connection location. As was the case with a gate or taxiway delay prior to departure, any time spent waiting to deplane from the inbound aircraft has a very high perceived cost. There is also a similarity with *Gate Area Time*, in that arriving at a connecting gate early entails waiting time under similar circumstances.

Transfer connection time has been studied in detail for air travel *(25)*. The theory in that work suggests that each traveler determines an optimal amount of connection time that considers the likelihood of missing a connection, the benefits of having adequate time for such activities as eating, use of a phone, and dealing with personal comfort—all being traded off against a general desire to reduce overall travel times. The empirical work finds that air passengers on average perceive additional benefits from up to 15 minutes above the minimum connection times allowed by airlines, but that these benefits gradually turn to disbenefits as connection times are lengthened beyond that amount. It is reasonable to expect that this additional time will vary as a function of overall flight time, with passengers on long-haul flights potentially having a greater desire for slightly longer connection times. As described, connection times are primarily an issue for airline operations planning and less so for airport design, except where international connections are involved *(25)*.

Components 8 and 9: Deplaning and Walking or Riding to Baggage Claim or Terminal Exit, Baggage Pick-up, and Terminal Egress Time.

These components are similar to the corresponding components in the opposite direction at the departure airport. Walking or riding to baggage claim or the terminal exit is similar to component 4, while terminal egress time is similar to component 2. Baggage pick-up is similar to flight check in (part of component 3)—it involves waiting for an uncertain amount of time in an environment in which there are limited opportunities for other activities except perhaps making phone calls, similarly to waiting for flight check-in or security screening. The importance of reliability is diminished, compared to making the initial departure flight, but may not be entirely absent due to the desired schedule at the destination, particularly making connections to scheduled ground transportation. The commonly experienced lack of information on expected delivery times for baggage may increase the valuation for this component. In the case of international trips, immigration and customs add another layer of inconvenience, delay and/or uncertainty, similar to check-in and security at the origin airport.

Component 10: Ground Egress Time.

The time spent getting from the destination airport to the actual trip destination has characteristics similar to the initial *Ground Access Time* component. The importance of reliability is likely to be smaller than at the origin because most of the trip has now been completed. But the actual extent of extra time required by travelers may be greater if the destination city is unfamiliar, and the traveler is unsure of ground transportation options, or worries about getting lost.

Productive Use of Time Spent In Travel

Productivity deserves special mention because it particularly affects business travelers and so is likely to be highly valued and a prominent consideration by air travelers. Furthermore, it can be influenced by investments made by an airport authority or airline, for example, through the availability of power outlets or wi-fi service in a terminal or on an airplane.

In addition, the productivity of waiting time can affect the value of reliability throughout the trip because waiting at the gate or use of concessions in the gate area is a likely use of any extra buffer time travelers decide to build into their itineraries. If time spent waiting at the airport has similar utility to time at home or is as productive as time at the office, then travelers may be inclined to include more buffer time in their plans and, thereby, reduce the cost of unreliability in the time components getting to the airport and through the terminal.

However, there are some limitations to the possibilities of reducing values of time and reliability by productivity-enhancing technology. One is privacy. Travelers may avoid making phone calls on sensitive business matters where other people can overhear them, or using a laptop for company business in situations where people sitting next to them can see their computer screen. A second limitation is space and comfort. Many airline seats and crowded departure lounges make it difficult to work on a laptop computer, while access to power in order to preserve battery charge can be a further limitation (witness travelers sitting on the floor to be within reach of a power outlet). A third consideration is the continuity of the activity in terms of location—productive work often involves some setup time which makes a block of uninterrupted time in one location more productive than several shorter blocks of time separated by movement from one place to another. Indeed, the fact that an air journey is inherently split into many different components reduces the ability to use travel time productively and, thus, keeps values of time and reliability fairly high.

Other Considerations

The effect of income on value of time is likely to be strong for any of these components of air travel, in part because higher-income people often are concerned to use their time productively and, as a result, are more willing to pay for amenities, such as a quiet and uncrowded environment.

Secondly, air passengers often travel in parties of more than one, which has implications for assessing the value of time. For example, it is unlikely that children have the same value of time as their parents. Also, the presence of children changes the way the adults traveling with them use their time during trips, with implications for their perceived values of time. Third, the costs of many ground access and egress modes do not vary proportionally with the size of the travel party which, in turn, affects the way empirical studies can infer values of time from people's choices.

MODELING RESULTS

The empirical results reported here are based on an SP survey developed for ACRP 03-19 *(2).* Replies from 1,171 respondents were included in the model estimation. In order to keep the survey instrument to a reasonable level of complexity for respondents to handle, several trip components of the list described earlier were omitted from the survey and the SP experiments used two separate conjoint exercises – one covering attributes related to airport ground access and in-airport time components up to the point of aircraft boarding, and a second covering attributes related to the flight itinerary.

The value of time is defined as the marginal rate of substitution between time and money—namely, the amount of money that a person would be willing to exchange for a reduction in some specific component of travel time, while maintaining the same level of utility, or satisfaction. These rates of substitution are given by the ratios of the time and cost coefficients in the estimated linear utility functions in a choice model such as the multinomial logit model used in the current study. These coefficients show the change in utility for any given change in the time or cost variables. By using data that can distinguish separate time components, each can be used as a separate variable in the choice model so that separate values of time for these components can be estimated. Details of the model estimation, including the sample sizes, model fit statistics, and standard errors of the coefficient estimates, are given in the project final report (Volume 2 of ACRP Web-Only Document 22 *(2)*).

Table 2 shows the estimated WTP values for business and leisure travelers without considering income. As can be seen in the table, the values for business travelers are consistently higher for each time component as compared to the corresponding values for leisure travelers. Additionally, there are considerable differences in WTP values for various time components. It should be noted that the WTP values for flight time and the expected value of flight delay were estimated from a different set of stated preference choice experiments than the on-ground time components. The flight times and airfares presented in the flight itinerary choice experiments were generally larger in magnitude than the airport access times and costs presented in the on-ground time components choice experiments. Because of potential scale effects (e.g., $5 on a $20 taxi fare could be perceived as much more onerous than $5 on a $600 airfare), this difference in the magnitude of the travel time and cost variables could have an impact on the WTP values.

The last two rows suggest that the WTP value for reductions in expected flight delay (which is calculated by multiplying the probability of being delayed by the average amount of delay for delayed flights) is perceived as 5.6 times the WTP value for flight time savings for business travelers and 3.5 times the WTP value for flight time savings for leisure travelers.

TABLE 2 Willingness-to-pay Values (in $/hour) – Business and Leisure Travelers

Component	WTP - Business	WTP - Leisure
Airport Time Components Choice Experiments		
Ground access time	$18.60	$16.95
Terminal access time	$33.85	$26.01
Check-in and security time	$37.19	$28.45
Time to reach the gate area	$32.25	$22.83
Gate time	$20.48	$17.62
Flight Itinerary Choice Experiments		
Flight time	$51.01	$34.91
Expected flight delay	$286.32	$123.30

Finally, the values of various time components segmented by income are shown in Table 3 and Table 4 for business and leisure travelers, respectively. The income is the respondents' annual individual income from the previous year (2012) as reported by respondents in the survey. As expected, the willingness-to-pay values follow an upward trend as the income levels increase.

TABLE 3 Willingness-to-pay Values (in $/hour) by Income – Business Travelers

	Individual Income (2012 $ before taxes)		
Component	**Less than $75,000**	**$75,000 - $199,999**	**$200,000 or more**
Airport Time Components Choice Experiments			
Ground access time	$13.92	$21.31	$38.49
Terminal access time	$23.75	$36.34	$65.66
Check-in and security time	$27.75	$42.45	$76.70
Time to reach the gate area	$22.63	$34.62	$62.55
Gate time	$14.23	$21.78	$39.34
Flight Itinerary Choice Experiments			
Flight time	$33.66	$58.91	$100.99
Expected flight delay	$186.34	$326.09	$559.01

TABLE 4 Willingness-to-pay Values (in $/hour) by Income – Leisure Travelers

	Individual Income (2012 $ before taxes)		
Component	**Less than $75,000**	**$75,000 - $199,999**	**$200,000 or more**
Airport Time Components Choice Experiments			
Ground access time	$14.56	$16.63	$22.14
Terminal access time	$22.09	$25.22	$33.58
Check-in and security time	$24.27	$27.71	$36.90
Time to reach the gate area	$19.27	$22.01	$29.30
Gate time	$14.91	$17.03	$22.67
Flight Itinerary Choice Experiments			
Flight time	$30.05	$41.18	$95.43
Expected flight delay	$107.11	$146.77	$340.16

Comparison of Survey Ground Access WTP Values with Current U.S. DOT Guidance

These estimated WTP values for airport ground access can be compared to the recent guidance on the value of travel time savings for use in economic analysis issued by the U.S. DOT, which includes both air and surface modes *(1)*. The U.S. DOT recommended values for surface modes are broadly consistent with the WTP values for airport ground access estimated from the SP survey choice experiments conducted for this research project. Table 5 compares the SP ground access WTP values to the value of travel time savings (VTTS) from the U.S. DOT guidance for local and intercity surface trips. In comparing these values, we assume that although "local travel" reflects the typical distances and modes of ground access trips made by air travelers to airports, the "intercity" values may be closer to the perceived VTTS for these trips, which form part of an intercity journey.

TABLE 5 Comparison of Ground Access WTP Values with U.S. DOT Surface Transportation Value of Time Guidance

Trip Purpose	**SP Survey (2013 $/hour)**	**U.S. DOT Local (2012 $/hour)**	**U.S. DOT Intercity (2012 $/hour)**
Business	$18.60	$24.10	$24.10
Leisure	$16.95	$12.30	$17.20

Note: The SP survey used the term leisure travel, while the U.S. DOT guidance uses the term personal travel. It is assumed that these are equivalent, since the term leisure travel in the SP survey covered all non-business travel.

The values in U.S. DOT guidance for business travel are higher than those estimated in the current study, while those for personal local travel are lower than the WTP values estimated from the SP survey for leisure trips and the values for intercity personal travel are similar. The U.S. DOT values for local travel by surface modes covers all local travel by all travelers. To the extent that air travelers have a higher average income than travelers in general, it could be expected that the VTTS for airport ground access trips would be higher than for local travel in general.

The values for business travel in the U.S. DOT guidance are based on a percentage of the hourly median gross compensation, including fringe benefits, rather than any behavioral response of travelers making a business trip as in this research. While it may be argued that this is the value to the employer of any travel time savings, as the U.S. DOT guidance suggests, it may be quite different from the perceived VTTS to the traveler, as measured in the current study. Therefore, while it is useful to compare the values in the U.S. DOT guidance to those estimated in the current study to see how consistent they are, it is important to bear in mind the differences

in methodology used in the deriving the two different sets of values. In particular, the U.S. DOT guidance does not explicitly provide different values for travelers with different income levels, as was done in the current study, although the difference between the VTTS values for intercity travel by surface modes and those by air travel (shown in Table 1, above) in the U.S. DOT guidance is largely justified on the grounds that air travelers have a higher median household income than households in general.

U.S. DOT guidance recommends that personal travel be valued at 50% of business travel for transit and 70% of business travel for intercity rail. Findings from the SP survey show similar ratios of value of time for personal to business travel as the U.S. DOT guidance for intercity rail, with ratios for flight time, terminal access time, check-in and security time and time to reach the gate area ranging from 68% to 77%. But they show significantly higher ratios of 86% and 91% for ground access time and gate time, respectively.

Although the U.S. DOT guidance does not distinguish between travel time and delay, the SP findings show a much larger spread in the values of time for expected flight delay between business and leisure trips, where the value of expected flight delay for leisure travel was found to be only 43% of that for business travel, implying that leisure travelers are generally less affected by (and less concerned about) flight delays than business travelers.

CONCLUSIONS

Recent changes in airport configurations and operational policies, including terminal amenities and technology available to passengers, have changed the way that travelers are able or compelled to manage their time at airports. What was once "wasted time" can now be used as productive time, and that increased options for entertainment, dining and shopping can enhance what was formerly a less enjoyable wait time. On the other hand, security procedures have introduced new sources of uncertainty in the time required to get through the airport terminal to the gates.

The research presented in this paper analyzed the value of travel time from the perspective that the various segments of an air trip each have a unique value of time that differs between business and personal travelers. For example, the research found that passengers are willing to pay more for a reduction in the time spent in security lines than in waiting at the gate for a flight.

It follows that the value of travel time appropriate to evaluate a proposed capital investment will differ depending on which trip components it affects. The use of different values of time for different components of an air trip represents a major advance in how benefit-cost analyses can be approached and capital investment decisions can be considered.

Future Research Needs

The results presented in this paper represent an initial set of values of air traveler time for different components of an air trip. However, these values will need to be updated, expanded, and refined by future research. A much larger sample SP survey would allow various aspects that were not addressed or resolved in the current research to be explored, including the valuation of airport terminal amenities and how these affect the perceived value of waiting time. The final report of the project, Volume 2 of ACRP Web-Only Document 22 *(2)*, includes an extensive discussion of future research needs identified in the course of the project.

Measuring the Value of Time by Trip Segment in Other Modes

Although this research is limited to air passengers, the segmentation of willingness to pay by different trip segments could also be applicable to other modes. Passenger rail, intercity bus and water transport have similar characteristics to air travel, in that their stations and terminals involve access and egress travel, wait times, and scheduled departures and arrivals, while the time spent in travel on each mode is influenced by the vehicle speed, the number of any transfers required, and the potential for delays. In fact, wait times are currently incorporated in value of time assessments for transit when proposed improvements are considered that will affect transfers between routes or lines. The usefulness of trip segmentation may be limited for highway travel due to the preponderance of individual car ownership, which provides the ability to make an origin to destination trip in the same vehicle at any desired time. Nevertheless, the value of travel time by car has been found to differ by the amount of congestion encountered, and it may also differ by the type of road or highway being used, the availability of hand-free communication technologies, and other factors.

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