Passenger Level of Service and Spatial Planning for Airport Terminals

DETAILS

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Transportation Research Board

AIRPORT COOPERATIVE RESEARCH PROGRAM

ACRP REPORT 55

Passenger Level of Service and Spatial Planning for Airport Terminals

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AIRPORT COOPERATIVE RESEARCH PROGRAM

Airports are vital national resources. They serve a key role in transportation of people and goods and in regional, national, and international commerce. They are where the nation's aviation system connects with other modes of transportation and where federal responsibility for managing and regulating air traffic operations intersects with the role of state and local governments that own and operate most airports. Research is necessary to solve common operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the airport industry. The Airport Cooperative Research Program (ACRP) serves as one of the principal means by which the airport industry can develop innovative near-term solutions to meet demands placed on it.

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FOREWORD

By Lawrence D. Goldstein
Staff Officer
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ACRP Report 55 examines passenger perception of level of service (LOS) related to space allocation in specific areas within airport terminals. The objective of this research was to evaluate appropriate level-of-service standards applied in the terminal planning and design process while testing the continued validity of historic space allocation parameters that have been in use for more than 30 years. These original standards have often been questioned but never revised or replaced. To accomplish this objective, the researchers used a new approach to measure how passengers perceive the sufficiency of space, relying on quantitative data in combination with ethnographic interviews. Interviews were conducted on site within the terminals at seven case-study airports. The research also examined what other factors might affect positive perception of level of service, such as availability of extended information resources plus opportunities for use of technology (wireless connectivity, power connections for computers and other electronic equipment, and other innovations).

ACRP Report 55 provides space allocation parameters for each terminal processing area, as well as important considerations for refining specific applications. In addition, guidelines include criteria for implementing these space allocation parameters, recognizing that higher levels of area per passenger do not necessarily contribute to improved perception of LOS. The research also concludes that perception of LOS is enhanced by effective information displays that provide schedules and boarding information so that passengers do not have to remain in the boarding area at all times.

Airport architects, engineers, and planners can use the guidelines provided to help determine space requirements and other design parameters that result in passengers perceiving spatial areas to be both sufficient and efficient, while providing an acceptable level of service. In addition, airport operators and airline personnel can use the information provided to determine how to allocate terminal space to serve passenger needs efficiently and effectively. Both groups can plan for and incorporate advanced information systems to broaden the use of all space within the terminal, offering greater flexibility to meet changing demand for service as a function of variable levels of activity.

The research for *ACRP Report 55* shows that if airport planners and designers as well as airline operators want to improve passenger perception of the quality of the airport terminal, it is important to provide all processors and staffing necessary to minimize passenger wait times at ticketing (counters and kiosks), security screening, and baggage claim areas. To improve user perception of the quality of passenger services, designers and operators also need to determine what amenities passengers rely on in an era of increasing demand for communication and access to technology designed to enhance productivity as well as personal entertainment. An important conclusion of this research is that passengers want easy access to information about flight status, clarity in signage, and additional amenities that allow them to use their time productively or to relax and enjoy an escape from the demands of travel.

A primary finding of this research is that larger space by itself does not always generate increased passenger perception of high-quality LOS. Overall perception of quality of service is the result of a combination of factors that address productivity during wait times as well as access to a variety of services with options other than just waiting prior to aircraft boarding. In addition, if airport terminal designers and managers in concert with airline operators want to provide passengers with a world-class terminal, qualitative as well as quantitative facility design factors should be considered early in the planning and design process. To continue to improve the process of understanding passenger needs, more effective techniques are necessary for surveying passengers and collecting and evaluating relevant information. In particular, the airport industry needs to identify more effective ways to collect data on how passengers perceive level of service and what quantitative and qualitative factors are important in a particular terminal environment.

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Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

AUTHOR ACKNOWLEDGMENTS

Activities at airports are dynamic and ever-changing. These activities require constant monitoring and staff attention. Even so, the airport staff at each of the seven research airports was gracious to give their time to help our team gain access to the airport and provide information required to conduct our research. In all cases, they helped us navigate local security protocols and requirements, and in many cases, they provided escorts from their own operations staff to allow us to do our work in a compressed time frame.

Special thanks go to the staff at Austin Bergstrom International Airport, especially Patti Edwards, Denise Hatch, and Jonathan Lian; Dallas-Fort Worth International Airport, especially Jeff Fegan, Jim Crites, Chief Charles Deel, Andy Bell, and Stephanie Green; Dulles International Airport, especially Jim Bennett, William Lebegern, and Anthony Dockery; Hartsfield-Jackson Atlanta International Airport, especially Ben DeCosta and Daniel Molloy; Las Vegas McCarran International Airport, especially Randy Walker and Rosemary Vasilades; Louisville International Airport, especially Charles Miller, Karen Scott and Steve Petty; and Oakland International Airport, especially Steve Grossman, Kristi McKinney, and Joan Zatopek.

This study relied on the services of a group of aviation industry professionals—referred to as the "Red Team"—to review the initial analyses and findings of the research. These individuals contributed their time and money to participate in the meeting and/or review the research findings and provide important guidance. They include Bruce Anderson and Matt Lee (Landrum & Brown); Joel Hirsh (Hirsh Associates); Marion White (Gensler); Natalie Martel (Tecsult/AECOM); Evan Futterman (Futterman Consultants); Paula Hochstetler (Airports Consultants Council); Richard Marchi (Airport Council International–North America); and David Lind, Jonathan Massey, Phil Mein, and John Murphy (Corgan).

Special thanks to two good business partners and friends: Joe Waller at HMS Host, who generously provided gift cards to use as thank you gifts for the time airport professionals took to respond to online surveys and other data collection activities; and Les Cappetta and Patrick Murray, at SSP America, who generously shared their proprietary research on passenger perceptions of level of service.

Finally, the research benefited tremendously from the guidance provided by our panel, listed in the front pages of this book, especially our panel chair, Theodore Kitchens, who provided support and insightful guidance at each step along the way.

SUMMARY

Passenger Level of Service and Spatial Planning for Airport Terminals

The objectives of ACRP Project 03-05, "Passenger Space Allocation Guidelines for Planning and Design of North American Airport Terminals," were to develop standard space allowances for passengers in each area of the air terminal, to identify an appropriate level-of-service (LOS) framework, and to identify a dynamic or holistic measure representing a passenger's overall experience of the journey. This project presents an opportunity to complete research on North American passengers' perceptions of airport service as a function of the amount of space surrounding them as they travel through each processing element of the air terminal. For over thirty years, airport planners, designers, and operators have used research and standards developed many years ago, in other countries, and in some instances in other transportation facilities as the basis for North American airport LOS guidance. Prior to the completion of this ACRP research effort, the LOS framework predominantly used by aviation stakeholders had been the International Air Transport Association (IATA) LOS framework, derived from similar standards first promoted by John Fruin and documented in the *Highway Capacity Manual* and the Airport Associations Coordinating Council LOS framework.

The basic premise of the LOS framework is that passengers are sensitive to the amount of space surrounding them and as that space is reduced by crowding, they perceive it as a deterioration of service. By how much and why, however, continued to be a question. Research in the early 1990s led some aviation planners to question the validity of the tie between passenger perceptions of LOS and space. Some thought time was more important, and others thought perceptions of LOS were driven by other factors, some unique to individual terminal processors. Many planners debated the applicability of space standards derived for international passengers rather than for North American domestic passengers since cultural differences may influence passenger perceptions. Additionally, many planners believed that factors associated with passengers' trip purpose (e.g., business versus leisure) or air carrier type (e.g., domestic versus international or legacy carrier passenger versus low-cost carrier) also influenced passengers' perception of LOS.

The TransSolutions team was selected to develop a space-planning guideline for each air terminal processing area as well as to develop a dynamic or holistic measure indicating the LOS for a passenger's entire journey through the air terminal. To achieve these objectives, TransSolutions conceived a data collection approach that included both quantitative data (passenger wait time and available space at each processor tied to a query about the passenger's perceived LOS) as well as qualitative data based rather innovatively on an ethnographic interview and *in situ* (in the place) observation technique. The TransSolutions team used this approach to data collection to produce passenger space guidelines that yield favorable passenger perceptions of LOS as well as to identify the drivers of passenger perception in hopes of discovering a holistic or dynamic metric for overall passenger journey satisfaction.

North American airports selected for data collection sites represent the spectrum of airport design, air market service, and passenger type so that any differences in passenger perceptions tied to these differences could be identified. Approximately 4,000 wait-time or density data points tied to passenger perceptions were collected at each airport processor at seven U.S. airports. Additionally, 242 ethnographic interviews and in situ observations were conducted at four of the airports. The data were analyzed to identify the drivers of passenger perception.

Analysis of the data produced the following findings:

- No relationship was identified between a positive passenger perception of LOS and density itself.
- The data clearly indicate that positive passenger perception of LOS is ***not*** tied to lower density, an exciting finding that will help the aviation industry invest scarce development resources wisely.
- Positive passenger perception was found to be associated with lower wait times in four areas: staffed agent check-in, kiosk check-in, security screening checkpoint, and baggage claim. Passengers are tolerant of wait times of 25 min or less, consistent with previous studies.
- No difference was identified between business and leisure travelers' perception of LOS, and generally no difference was identified between passenger perceptions of LOS based on air carrier type differences.

The results of the ethnographic data collection provide important clues regarding the drivers of passenger perception. A key finding is that in order to reduce passengers' stress and thus increase their perceived LOS, it is important that they feel in control of the success of their journey. The findings identifying lower wait times associated with higher perceived LOS are consistent with this driver. Additional areas affecting terminal planning include simple, intuitive wayfinding, short walk distances, and ubiquitous and reliable flight information status.

The ethnographic data also indicated a need for terminal amenities that reflect a respect for passengers' time and needs. These include the desire for Wi-Fi and electrical outlets so that they can plug in their electronic devices to be productive as they wait. Passengers also need sanctuary as they wait. For some, this may be a quiet place, while others may want a place to watch sports or news. The space-related driver of passenger perception is not density but the quality of the space related to passenger needs.

Some study conclusions are highlighted in the following:

- While the clear objective of the study was to produce a new space-planning guideline, analysis of over 4,000 data points indicated that the IATA LOS C metric is a good basis for planning. Chapter 5 of this document provides the IATA LOS C standards from the latest (9th) edition of the IATA *Airport Development Reference Manual* (*1*) along with some important caveats about matters to consider when using the standard. This space-planning standard has been used for terminal planning for the last 35 years, and this research indicates that passengers are satisfied with the terminal densities that result. The study found few instances of passenger density worse than LOS C, with instances of passengers actively self-regulating their experience to avoid such conditions by moving to another, less crowded area. These observations support the validity of continuing to use the IATA LOS C standard.
- There is no basis for allocating additional space to terminal processing areas in excess of the LOS C guideline in an attempt to produce higher passenger perceptions of LOS. The study concludes that space should be planned using the necessary numbers of processing elements to achieve acceptable wait times and the LOS C guideline for the design year of

the facility. Thus, facilities may open with a space-planning factor greater than LOS C but will grow into the LOS C as demand increases and the facility nears the passenger loads expected for the design year used in facility programming.

- Terminal planners should incorporate all necessary types of terminal processors in adequate numbers, including the space necessary to accommodate those processors and their associated queuing, for the design year so that a LOS C in those processing areas is maintained and passenger wait times are minimized.
- Terminal planners and designers should take care to consider early in the terminal design ways to improve wayfinding through intuitive building design, clear sight lines, minimal level changes, and effective signs when clear sight lines cannot be achieved. These considerations cannot be left to the end of the design process.
- Incorporation of passenger amenities that support passengers' expectations to use their time to accomplish work or be productive while they wait, as well as areas for relaxation tailored to diverse passenger needs, is fundamentally important for terminal design to produce high passenger perception of LOS.
- It is necessary that terminal planners and designers incorporate flexibility into any design, since travelers' changing needs and demands within the next 5, 10, or more years is unknown today.

The TransSolutions team also recommends for further study that the industry research and identify new, less costly ways to collect passenger perception data. The TransSolutions team used a one-on-one interview survey technique, with few questions and minimal inconvenience to passengers—a standard industry approach to passenger behavior surveys. However, even the best passenger intercept survey techniques introduce the potential for some bias. Many passengers will not respond or participate, based on their perception that they will be delayed. The authors have identified promising new approaches that include questionnaires administered via mobile technology and passive monitoring of passenger wait time using GPS and blue-tooth technology. Identification of more effective data collection techniques is essential for further study of passenger attitudes regarding LOS.

CHAPTER 1

Background

Planning and designing airports to serve passengers and ever-evolving operational needs is challenging. It is even more challenging to achieve the correct balance of using limited capital investment resources while developing facility designs that provide the design flexibility to accommodate as yet unimagined operational requirements to fulfill safety and security measures, as well as to serve the needs of communities and their passengers. Aviation planners, architects, and engineers, as well as airport owners and airlines (referred herein collectively as aviation stakeholders), currently rely on level-of-service (LOS) standards that were developed in the early 1970s by the International Air Transport Association (IATA) to help them make important development decisions. Within the last decade, given the diversity of passengers and airline service products, aviation stakeholders continually speculate regarding the adequacy, validity, and robustness of these various standards. As a result, the Transportation Research Board proposed Project 03-05, "Passenger Space Allocation Guidelines for Planning and Design of North American Airport Terminals," for sponsorship by the Airport Cooperative Research Program.

This report presents the findings of research regarding the basis of North American passengers' perceptions of airport LOS and offers guidance for airport development. The intended audience includes airport and airline management and other aviation stakeholders.

A Brief Historical Perspective of Air Passenger Level of Service

In 1971, John J. Fruin published *Pedestrian Planning and Design* (*2*), which documents the results of his research on pedestrian behavior on urban sidewalks and in transit stations. The guidance on pedestrian behavior includes both standing/waiting behavior (space requirements) and walking behavior (on walkways, stairs, and elevators). The guidance includes square-foot-per-pedestrian requirements as they stand or wait in areas such as railway platforms. The guidance is presented in a framework similar to traffic engineering studies that associate letter grades (A through F; where A is excellent and F is poor) with square feet per passenger.

Initial efforts to develop formulaic design guidance on air passenger LOS can be traced to Transport Canada in 1977 (*3*). In their "Level of Service Requirements for Passenger Processing Areas in Airport Terminals," Transport Canada developed LOS requirements for each passenger processing area in the airport terminal. Review of the paper indicates that the space ranges were based on data collected at a limited number of Canadian airports.

In 1978, the Airport Associations Coordinating Council (AACC), the precursor to today's Airports Council International (ACI), and IATA initiated a study on airport capacity that resulted in the first edition of the *Guidelines for Airport Capacity/Demand Management* (*4*), which contained a tabular presentation of LOS guidelines by airport processing area. This guidance was incorporated into IATA's *Airport Development Reference Manual* (*1*) and remained unchanged through the 8th edition. In the 9th edition (published in 2004), new information regarding the formulation of the standards is provided; however, the LOS ranges remained largely unchanged.

The view that passenger space drives passenger LOS perception was questioned in 1991, when Seneviratne and Martel published a paper entitled "Variables Influencing Performance of Air Terminal Buildings" (*5*) that concluded, based on passenger intercept studies, that different variables drive passenger perceptions in each air terminal area. For example, "information" was found to be the most important variable affecting passenger perception of circulation areas; "availability of seats," as distinct from the space to accommodate those seats, was found to be the most important variable affecting passenger perception of waiting areas; and "waiting time" was found to be the most important variable affecting passenger perception of terminal processing areas. In a finding that foreshadowed this study's findings, in every terminal element studied, less than 10% of passengers cited "availability of space" as a variable that influenced their perception of air terminal performance. In that paper, the authors' reference research conducted in 1975 by Brink and Maddison (*6*) regarding quantitative and qualitative factors that influence performance—specifically that these variables can be divided into physical and psychological comfort variables. Another intriguing finding by Seneviratne and Martel is that there is no significant difference between the ranking of business and leisure passengers. Several of this paper's findings are supported by the Seneviratne and Martel paper's research conclusions.

In 1994, Seneviratne and Martel continued their research with "Criteria for Evaluating Quality of Service in Air Terminals" (*7*), premised on the conclusion that passenger density and the six-level scheme to rate terminal subsystem performance were inadequate.

In 2001, Caves and Pickard (*8*) presented "The Satisfaction of Human Needs in Airport Passenger Terminals," concluding that after the need for safety, the most important categories that passengers need in order to feel at ease are time and the elimination of unknowns. Their work highlights the importance of good wayfinding to meeting both of these needs, again supported by this research.

The project team also looked outside the aviation industry to find research on physical planning standards that influence patron perception of LOS. Much research exists that considers service quality, but in airports most aspects of service quality are controlled by airlines or federal agencies, not airports. However, the literature search identified one paper relevant to the hotel industry that discussed how physical planning standards influenced patron perception of LOS. In 1995, Martin related research in "An Importance/Performance Analysis of Service Providers' Perception of Quality Service in the Hotel Industry" (*9*). The research references work done by Parasuraman, Zeithaml, and Berry in 1986 that found that service quality as perceived by customers involves five dimensions: tangibles (physical facilities, equipment, and appearance of personnel), responsiveness, assurance (knowledge and courtesy of employees and their ability to convey confidence), empathy (degree of caring), and reliability (promised service is performed dependably). Based on a questionnaire for management and employees, the work showed that although differences exist between management's and employees' perceptions of what is important and acceptable to customers, both groups failed to accurately perceive customers' opinions regarding service. The paper notes that quality service is not simply doing things well, but rather that it is necessary to understand what is important to the customer and then do those things well.

Research Approach

Discovering What Passengers Really Think

A critical aspect of the success of the project was to discover what truly does influence a passenger's perception of LOS. To help uncover the drivers for passenger perception, the TransSolutions team chose to use traditional quantitative measures associated with time and space (to attempt to quantify passengers' perceptions of LOS), complemented by non-traditional qualitative measures to add insight to compiled data.

Ethnographic research is also called *in situ* (situational) or in-context research. It is a methodology used to uncover and understand passenger behavior. The process uses methods employed by cultural anthropology to interactively observe passengers in actual situations and to understand—and later predict—passenger reactions. Ethnographic research reveals passenger attitudes, motivations, expectations, and psychology. It thereby offers a reality check in terms of understanding passengers. The unique benefit of ethnographic research to this effort is the discovery process: uncovering passenger motivations and concerns otherwise unknown.

A full ethnographic research effort would involve selecting passengers before their trip day; accompanying them from their home or other starting point to the airport, through every stage of the process; and accompanying them onto the aircraft. The effort could also continue with accompanying the passengers through their arrival processing at their destination airports until they exit the terminals. A person trained in ethnography will be able to draw out the necessary information without affecting the passengers' behavior.

Project constraints did not support a full ethnographic research effort. Therefore, in response to project constraints, to be less obtrusive with the passenger processes, and to synchronize collection of quantitative process data with qualitative perception data, the TransSolutions team conceived a hybrid approach, combining ethnographic techniques with passenger intercepts. Passengers were questioned in the observed facilities during the data collection periods in order to capture perceptions during the same time periods that quantitative data were being recorded.

Research Objectives and Approach Evolve

Research proceeded based on a project plan selected and approved by the ACRP Project Panel. However, as the project progressed, the initial research approach changed at two important junctures.

The first consequential change involved the timing of the Interim Report. As initially conceived, the study Interim Report was to be published upon conclusion of the literature search, the airport planning survey, and preparation of the data collection plan. However, given the timing of the contract award, this schedule would have resulted in airport performance data being collected during the slower winter travel season. The TransSolutions team requested and received a no-cost extension to the study schedule to facilitate data collection during the summer—the typical period used as the basis for airport planning. This change also supported completion of a test data collection at Dallas/Fort Worth International Airport (DFW) during the busy spring-break travel period. Data collected during this period were analyzed and reported to the Project Panel as part of the Interim Report.

Analysis of the test data collection led to the second consequential change in the research study. The test data collection was conducted at DFW Terminals C and D. These two terminals were selected because, although they both serve the same air carrier, the physical features of the two terminals are significantly different. Terminal C was built in 1973 and, regardless of expansion through the years, the corridors are narrow, the passenger waiting areas are confined, and the ceilings are low.

In contrast, Terminal D opened in 2005 and has wide corridors, spacious passenger waiting areas, and high ceilings. Theoretically, the contrast between these two terminals should provide a fertile opportunity to discern gradations in passenger perception of LOS based on space per passenger.

Completion of the data analysis showed no difference between passengers' perception of LOS based on differences in the quantity of space provided in the same processing area in each terminal. This finding contradicted the prevailing view that passengers' perception of higher levels of service was based on less-dense concentrations of passengers (i.e., larger areas per passenger) in each processing area. As a result of this finding, the TransSolutions team, with the permission of the ACRP Project Panel, changed the data collection plan by reducing the total number of airports studied to provide a larger data collection budget per airport. The objective was to ensure that sample sizes of both quantitative (time and space observations) and qualitative (LOS perception observations and interviews) data would support conclusive study findings.

The research continued with collecting data at six more airports. Sample airports had diversity in size, air carrier type, and facility configuration. The findings of the research, recommendations for further study, and proposed guidelines for LOS planning are provided in subsequent chapters.

CHAPTER 2

Research Approach

Project Description

As previously stated, the objectives of this research were to develop passenger space allocation and LOS guidelines for terminal functional areas and a holistic metric for a passenger's overall airport experience.

Our research premise is that by combining the results of the quantitative and qualitative data collection presented herein, we can reach some conclusions regarding factors that affect passenger perception of LOS in the airport environment and then use those to determine guidelines for building airports in the future and redesigning existing infrastructure.

Study Design

Initial Approach

The TransSolutions team's approach was to develop a data collection methodology that used both quantitative and qualitative approaches. TransSolutions was primarily responsible for the quantitative data collection and used methodologies that included time stamp, observation, and passenger intercept surveys to quantify measures of passenger service—including wait time, number of passengers in queue, and number of square feet per passenger. At the same time that quantitative data were collected, TransSolutions also asked passengers their perception of the LOS they were experiencing.

Strategic Insight Group (SIG) expanded on the qualitative aspects of data collection by using ethnographic data collection techniques in the form of passenger intercept surveys that explored the passengers' impressions (using open-ended questions) as well as by observing passenger behavior. One of the team's challenges was to develop a data collection methodology that complemented the efforts of each team member and secured findings that could be correlated between the two endeavors.

One of the first project activities was to survey all commercial service airports to assess their views regarding LOS, their prevailing practice regarding use of LOS standards in facility development (including which, if any, standards they used), and their willingness to participate in a data collection study. This was accomplished through an online survey. Of the 162 airports that were sent the survey, approximately 20% responded. Of those responding, 65% said they were familiar with LOS standards (most frequently referencing IATA standards) and used them to plan various elements of their facilities. However, only about 30% of respondents believed that a new, universal North American LOS standard would be a major improvement.

Impact of Passenger Differences on Passenger Perceptions of Service

The initial project approach was for data to be collected in airport passenger processing areas at 10 (later adjusted to seven) North American airports, to quantify objective measures of passenger service (processing and wait time, number of passengers in queue, square feet per passenger, and so forth), and to assess passenger perceptions regarding LOS.

An important aspect of the study's data collection plan design was to select airports that would allow characterization of many of the diverse passenger characteristics and airport facility characteristics that aviation stakeholders speculate affect passenger perceptions and hence potential differences in the types of airport facilities they desire. Additionally, data were to be collected at airports that use different airport design paradigms. The data were analyzed to determine whether such differences were significant relative to passenger perceptions.

Table 1 shows candidate airports that would provide a valid cross section of data to indicate the types of expected passenger characteristics to be explored in our selection of study airports. Airports indicated in bold were those chosen for this research project.

To develop a data collection methodology that would accomplish the study objectives, a team workshop was held to develop the airport survey instrument and perform other

Table 1. Examples of airports by category.

Characteristic	Category	Airport Size		
		Large	Medium	Small
Predominant passenger type	O&D	SEA, LGA, BWI, SAN	**OAK,** RDU, PDX, RNO, **SDF**	OKC, DAY, LIT
	Connecting	**DFW, ATL,** ORD, MSP, IAD	STL, MEM, HOU, CLE	—
Predominant carrier(s)	Legacy	ORD, **ATL**, MIA, IAH, IAD	STL, MEM, CLE, SJU	SAV, HSV, XNA
	Low cost	**ATL,** MDW, PHX, BWI, FLL	**OAK**, BNA, HOU, DAL	BIL, SFB, PHF
	No predominant carrier	LAX, JFK, MCO, HNL	MSY, BDL, SAT, MHT, **SDF**	HPN, MYR, ABE
Predominant destinations	International	LAX, JFK, **DFW** YYZ, SFO	SJU	GUM, GSN, SFB
	Domestic	DEN, **DFW,** LGA, BWI	All	PHF, PNS, BTV
Purpose of travel	Leisure	LAX, **LAS,** MCO, HNL	SJU, MSY, OGG, RSW	ACY, PSP, MYR
	Business	LGA, LAX, JFK, **LAS**	DAL, PVD, SJC, MCI	ILM, OKC, DAY
Terminal configuration	Centralized	**ATL,** DEN	PDX, DAL, ANC, **AUS**, **SDF**	ALB, MDT, LIT, SYR
	Decentralized	DTW, **DFW**, MCO, BWI	STL, SAT, BNA, YVR	—
Landside terminals	Single terminal	**ATL**, DEN, **IAD**, YUL	PDX, BNA, ABQ, ANC, DAL	TUL, MDT, ALB, DAY, PHF
	Multiple terminals	**DFW**, JFK	**OAK**, SAT	—

Note: O&D = origin and destination

task activities. Differences in quantitative and qualitative research concepts were discussed and folded into strategies by the quantitative and qualitative technical team leaders. From this, each team member built a strategy to best capture the relevant data needed from their particular discipline.

Data Collection Cities

TransSolutions targeted airports from Table 1 that allowed assessment of any differences that might exist between airports from each characteristic category. Airports that voiced a specific interest to be considered for data collection (in our online survey) were the first considered for on-site surveying. Table 2 details the study airports along with the categories and characteristics each airport represents.

Data Collection Methodology

Initial Approach

A pretest of the survey instruments at DFW airport was conducted during the week of January 28, 2008. Results from the pretest were reviewed and the data collection approach adjusted for the first data collection at DFW over President's Day weekend (February 15–18).

TransSolutions initially used four methods to understand passenger perceptions of level of service in relation to the space available to them and the process time involved in their journey:

1. Wait-time studies and observation of queue length correlated with passenger perception surveys,
2. Passenger surveys regarding perception,
3. Video capture and analysis of dwell time, and
4. Ethnographic research.

The team looked at the results of the DFW test and realized that analysis of the video data would be too time-consuming relative to the number of data points collected. The group redesigned the studies to accomplish the goals of the study in a more efficient manner. Essentially, all of the passenger intercepts were converted to a two-person process that could be completed without the use of videographic evidence. The first person would hand the passenger an ID card while ask-

Table 2. Categories and characteristics for subject airports.

Airport ID	Airport Name and Location	Airport Size	Predominant Passenger Type	Predominant Carrier(s)	Predominant Destinations	Purpose of Travel	Terminal Configuration (per Terminal)	Landside Terminals	FAA Region
DFW	Dallas/Fort Worth International Airport—Dallas, TX	Large	Connecting	Legacy	Domestic/ international	Leisure, business	Decentralized	Multiple	Southwest
AUS	Austin-Bergstrom International Airport—Austin, TX	Medium	O&D	Low cost	Domestic	Business	Centralized	Single	Southwest
ATL	Hartsfield-Jackson Atlanta International Airport—Atlanta, GA	Large	Connecting	Legacy, low cost	Domestic/ international	Business	Centralized	Single	Southern
LAS	McCarran International Airport—Las Vegas, NV	Large	O&D	None	Domestic	Leisure, business	Centralized	Multiple*	Western-Pacific
OAK	Oakland International Airport—Oakland, CA	Medium	O&D	Low cost	Domestic	Business	Decentralized	Multiple	Western-Pacific
SDF	Louisville International Airport—Louisville, KY	Medium	O&D	None	Domestic	Business	Centralized	Single	Southern
IAD	Washington Dulles International Airport—Dulles, VA	Large	Connecting	Legacy	Domestic/ international	Leisure, business	Centralized	Single	Eastern

*Smaller secondary terminal
Note: O&D = origin and destination

ing him or her several demographic questions and marking the time of the first interview. When the passenger reached the end of the process, a second interviewer would record the intercept time and complete the interview by asking the passenger what his or her perception of the process was on a five-point scale (where 1 is excellent and 5 is very bad).

Another alteration was made with respect to Federal Inspection Services (FIS) facilities. It was apparent from the test run that it was going to be impractical to obtain the proper number of escorts with the necessary language skills to fairly measure the perception of passengers within the FIS facilities. Given this reality, in addition to international flights' arrival times being highly variable and the limited availability of the data collection team's resources, the ACRP panel agreed on the cancellation of conducting FIS interviews.

Final Approach

After analyzing the results of the initial data collection, the team made the aforementioned adjustments to the scope and techniques and conducted six more full-scale data collections at the following airports between August 10 and September 17, 2008: Austin-Bergstrom International Airport (AUS), Hartsfield-Jackson Atlanta International Airport (ATL), Oakland International Airport (OAK), Louisville International Airport (SDF), McCarran International Airport (LAS), and Washington Dulles International Airport (IAD). In addition to DFW, concurrent ethnographic data collections were conducted at ATL, SDF, and IAD.

At each airport, all areas selected for data collection were documented. This included taking photographs and making physical surveys of the area to determine the size of the area for future calculations of space per passenger. It was not practical to obtain CAD drawings of the airport areas observed. Therefore, the data collectors were careful to determine the area that would be used for calculation of LOS based on

- In the check-in area, the queue area designated for waiting and the area designated for check-in service;
- In the holdroom, the seating area exclusive of the agent counter, queue, and jet bridge boarding/de-boarding area; and
- In the baggage claim area, the active claim area, defined as 11.5 ft from the face of the baggage claim devices.

For the quantitative passenger intercepts, the team conducted surveys of passenger perceptions in various areas of the airport. The areas where intercepts were conducted comprised the entire process-based passenger experience once inside the terminal facilities.

For passengers checking in, the curbside positions, ticket agent, or kiosk area typically provide their first interaction within the facility. Exhibit 1 shows select check-in areas at various study airports. Due to the short nature of the associated queues and wait times involved, for the kiosk process, the second interview occurred immediately after the passenger completed the kiosk process (but prior to bag drop-off).

All passengers must then proceed to the security screening checkpoint (SSCP) area, where uniformed Transportation Security Administration (TSA) agents conduct a passive search of the passengers and their bags and possibly recommend them for further screening. The waiting line for this process is actually divided into two areas by an ID check procedure. Prior to the ID check, passengers generally wait in a

Exhibit 1. Select check-in areas at study airports.

ATL – Curbside

ATL – Ticketing/ Delta Air Lines

OAK – Kiosk

single queue (or multiple queues, if the airport separates passengers by type—such as frequent traveler or preferred status), but once the ID check is complete, the passengers generally move into a set of smaller queues in front of each x-ray lane where they begin to divest their belongings.

It was important for the research to gauge passengers' perceptions of the experience prior to their actual interaction with the agent for that process, so our data collectors were stationed at the front and back of each process queue under review. For the SSCP, the interviews were done solely in the queues prior to the ID check process (see Exhibit 2).

Once the passenger exits security, the remaining areas of interest are not agent- or processor-based. Passengers move through the corridors and concourses, and those waiting for an automated people mover (APM) (for airports that have them) or waiting for boarding while in a holdroom do have an element of waiting involved (or the potential for congestion that slows movement, in the case of a crowded concourse or holdroom). For that reason, the interviews for these intercepts occurred at the entry and exit points for these facilities (see Exhibit 3).

Exhibit 2. Security screening checkpoint at IAD.

The only intercept conducted specifically for arriving passengers occurred at baggage claim (see Exhibit 4). It was performed similarly to the kiosk process above, although the first interview with the passengers occurred when they first arrived to the claim area, and the final interview occurred after the final passengers claimed their bags and were ready to depart.

Data Collection Schedule

The choice of data collection times and locations was driven by the desire to get the most quantitative data possible. Specifically, departing passenger demand was assumed to be heaviest during the early morning hours and late afternoon. Arriving-passenger demand was assumed to peak during the early to late evening. For those reasons, passenger check-in, SSCP screening, and holdroom intercepts were planned for the early morning and early evening, while bag claim intercepts for arriving passengers were scheduled for the 4 through 6 p.m. time frame, as shown in Table 3.

A total of three days' worth of data were taken for each airport, from Sunday afternoon to Wednesday morning. We expected this would provide a good cross section of participants that would potentially include leisure and business travelers.

Once a current flight schedule was obtained for the candidate airport, these times were modified to fit the actual passenger pattern at that specific airport. In order to maximize the total number of responses, airlines with a larger passenger share at a particular airport were scheduled for Monday collection since that day is traditionally a heavier demand day across the system. Statistically valid survey design techniques were used to ensure a representative sample of airlines for each airport with regard to check-in facilities and bag claim locations.

Exhibit 3. Corridor, APM, and holdroom intercept areas.

SDF – Corridor

DFW – APM area

AUS – Holdroom

Data Collection Procedure

Several questions were asked of the subjects to help classify the perception rating at the beginning of the process.

For check-in locations, passengers were interviewed prior to joining the queue in front of the agents or kiosks. They were asked the following questions:

- How many people are in the traveling party?
- How many bags are you checking?
- How many carts are you using?
- Is your trip primarily for business or leisure purposes?
- Is your trip to a domestic or international location?

For other airport locations, the passenger was asked

- Is your trip primarily for business or leisure purposes?
- Is your trip to a domestic or international location?

Exhibit 4. Baggage claim at LAS.

Additionally, the data collectors noted the start and end time of the processing and the number of people in the area of interest at the time of the observation.

- For the check-in and security processes, the passengers were interviewed when they entered the queue and again before they talked to the check-in agent or the ID checker prior to the security checkpoint.
- The processing time for the holdroom was calculated from initial passenger arrival at the holdroom area to the time they entered the boarding queue.
- The processing time for the APM stations was calculated from passenger arrival at the platform to subsequent boarding of the train.
- The calculation of the processing time for the corridor was completed by positioning the data collectors approximately 100 to 200 ft apart and intercepting passengers moving in the dominating flow direction. The data collectors were positioned so that there were no intervening holdrooms, restrooms, or shops to divert passengers.

The team thus collected objective passenger processing data, including wait time, number of passengers in queue, and square feet per passenger. Two instruments were used to conduct the survey in each case. First, a personal digital assistant (PDA) was used to accurately record responses to each of the questions posed by the interviewer. Second, a colored, numbered card was handed to the interview subject at the beginning of the queue and requested to be returned once the passenger reached the other interviewer at the head of the queue. By reconciling the time stamps for the particular passenger, the time spent waiting in process could be calculated. Passengers were asked at the end of the process to rank their experience on the scale shown in Table 4.

Finally, ethnographic research was conducted in areas of the airport to record in-depth passenger perceptions. Ethnographic data were collected on focused passenger processing

Table 3. Generic data collection plan.

<table>
<tr><th></th><th colspan="2">Sunday</th><th colspan="2">Monday</th><th colspan="2">Tuesday</th><th colspan="2">Wednesday</th></tr>
<tr><td rowspan="2">Morning</td><td colspan="2" rowspan="2">n/a</td><td>5:00 a.m.
to
7:00 a.m.</td><td>Ticketing
Concourse
Holdroom
APM</td><td>5:00 a.m.
to
7:00 a.m.</td><td>Ticketing
Kiosk
SSCP
Kiosk</td><td>5:00 a.m.
to
7:00 a.m.</td><td>Concourse
Holdroom
APM</td></tr>
<tr><td>7:00 a.m.
to
9:00 a.m.</td><td>Ticketing
Concourse
Holdroom
APM</td><td>7:00 a.m.
to
9:00 a.m.</td><td>Ticketing
Kiosk
SSCP
Holdroom</td><td>7:00 a.m.
to
9:00 a.m.</td><td>Concourse
Holdroom
APM</td></tr>
<tr><td>Afternoon</td><td colspan="2">Flight in
As required to arrive no later than 2:00 p.m.</td><td>9:00 a.m.
to
4:00 p.m.</td><td>Break</td><td>9:00 a.m.
to
4:00 p.m.</td><td>Break</td><td>9:00 a.m.
to
12:00 p.m.</td><td>Flight out</td></tr>
<tr><td rowspan="2">Evening</td><td>4:00 p.m.
to
6:00 p.m.</td><td>Kiosk
SSCP
Concourse
Ticketing</td><td>4:00 p.m.
to
6:00 p.m.</td><td>Curbside
SSCP
Bag claim</td><td>4:00 p.m.
to
6:00 p.m.</td><td>Curbside
SSCP
Bag claim</td><td colspan="2" rowspan="2">n/a</td></tr>
<tr><td>6:00 p.m.
to
8:00 p.m.</td><td>Kiosk
SSCP
Holdroom
Ticketing</td><td>6:00 p.m.
to
8:00 p.m.</td><td>Bag claim</td><td>6:00 p.m.
to
8:00 p.m.</td><td>Bag claim</td></tr>
</table>

at the ticket counter, security screening checkpoint, and baggage claim. In the holdrooms, research was conducted with the objective of evaluating the passengers' holistic view of their airport experience.

As the data collection process progressed from airport to airport, captured data (quantitative) points were cataloged as detailed in Table 5 to ensure coverage of major airlines and facility types.

Data Analysis Approach

For each condition, the data groupings were compared to determine if there was a difference in the average perception values using a standard statistical technique known as the *t*-test. The team verified that the underlying assumptions (regarding sample sizes, normalcy, and independence of the data points) for the use of this test were validated.

It was further assumed for the purposes of this analysis that the data collected were sufficiently representative of the national air-traveling public as a whole. We chose seven airports that varied in size, geographic location, and function, and collected data from passengers of many demographics and types, from solo business travelers to large families on vacation. *T*-tests were performed to determine if there was any significant difference between the responses for large and small airport types for a given factor before it was aggregated as shown in Table 6. Since for most areas there was no significant difference, we felt it appropriate to aggregate the data to attempt to form a national standard.

Using a standard statistical analysis approach, the null hypothesis for the *t*-test was defined. For this case, our null hypothesis was that the actual average perception ratings are equal for the two populations under consideration in each test (Data Group A and Data Group B). The calculated p-value represents a probability that corresponds to this question:

For an experiment of this magnitude, if the true populations studied really do have the same mean value, what is the probability of observing at least as large a difference between sample means as was actually observed?

If the p-value is less than a certain threshold (traditionally .05, or 5%), then we reject the null hypothesis previously stated and conclude that there likely *is* a difference between the average perception for the two data sets. Essentially, the lower the p-value, the more certain we are that the observed difference between data groupings is statistically significant. If we are unable to reject the null hypothesis, we cannot say with confidence that there is no difference; we were just not able to detect it with this experiment.

Once it is determined that the differences in the average perceptions are significant, we can examine the trends within each separate data group to determine when the average perception is likely to be worse than acceptable (in our case when the average perception rating = 3.0). This

Table 4. Passenger perception scale.

Scale	Description
1	Excellent
2	Good
3	Acceptable
4	Bad
5	Very bad

Table 5. Catalog of captured data points, IAD.

		Collection Location for Data Points						
Airline	**No. of Kiosks**	**Kiosk Bag Drop**	**Staffed Agent Check-In**	**Curbside Check-In**	**Baggage Claim**	**SSCP**	**Corridor**	**Hold-room**
Unknown	0	0	0	11	0	205	0	0
American	8	0	0	0	0	0	0	25
Delta	12	0	0	0	0	0	0	25
JetBlue	4	0	60	0	40	0	0	22
Southwest	6	0	0	0	0	0	0	25
United – domestic	50	39	60	27	150	0	100	35
United – international	22	0	73	0	0	0	0	39
Virgin America Airlines	6	0	0	0	0	0	0	25
Total Data Points Captured		39	193	38	190	205	100	196

Table 6. Measure of perception difference by airport size.

Functions	Small/Medium Airport Average Perception	Large Airport Average Perception	p-value	Significant Difference
Curbside	1.19	1.93	0.001	Yes
Ticketing	2.22	2.42	0.159	No
Kiosk	2.12	2.16	0.832	No
Bag drop	2.19	2.16	0.893	No
SSCP	1.99	1.89	0.310	No
Corridor	1.72	2.07	0.001	Yes
Holdroom	1.79	1.97	0.056	No
Bag claim	2.06	2.21	0.012	Yes

will become the nominal "turning point" (TP) of the environmental factor, the point where we find that the average perception switches from better than acceptable to less than acceptable based on the factor of interest (i.e., space per passenger or wait time). If there are no such significant trends available for a factor, then we cannot reliably determine a TP and thus cannot develop a design metric for that quantitative factor.

CHAPTER 3

Findings and Applications

Airport Use of LOS Standards

The TransSolutions team surveyed airports throughout the United States and Canada to determine what guidelines and parameters they used at their facilities for planning. The project team elected to use the online survey tool Survey Gizmo (www.sgizmo.com). Approximately 20% of surveyed airports responded.

Of the responding airports, 65% were familiar with LOS standards and used them to plan various elements of their facilities. However, only about 30% of respondents believe that a new North American LOS standard would be a major improvement.

Data Point Summary

Nearly 4,000 passenger intercept interviews were conducted successfully at the seven chosen airports. The quantitative and qualitative data collection teams combined efforts at four of the seven airports. Table 7 is a summary of the data collection methods used in each functional area and the number of data points collected that contained useable perception values.

There were a differing number of quantitative data points taken for each airport function across the seven airports due to passenger demand patterns and data collector scheduling. Table 8 shows the number of quantitative responses collected (that included a perception rating) by function at each airport.

The data from all seven airports were tabulated, and the average perception ratings for each of the airport functions were calculated. Table 9 shows the average perception ratings for each airport and each functional area.

Additionally, the data were summarized for small and large airports to identify any significant differences that might exist. This information is shown in Table 10.

Table 11 shows the average perception ratings for each functional area when the area per passenger for that process is taken into consideration.

Table 12 shows the average perception ratings for each functional area when the time spent in the queue for that process, or the process itself, is taken into consideration. Passengers' tolerance for wait times of 25 min or less, although seemingly rather long, is consistent with findings reported by Mumayiz and Ashford (*10*). In general, there is a tendency for the perception ratings to increase (i.e., to become worse) on average as the time spent increases. The bag claim, SSCP, staffed agent check-in, and kiosk areas show statistically significant increases over time.

Determination of Perception Turning Points for Area and Wait Time

Tables 13 and 14 show the breakdown of the conditions that were tested to determine if there were significant differences in the average perception ratings for a given airport function based on area per passenger. As noted in the previous chapter, the area used in the calculation was based on airport area surveys.

Using the approach described in the previous section, the data collected indicated TPs for the various functions, as summarized in Table 15.

No specific turning points were found for any functional areas when looking at the data for area available per passenger. Reported perception averages rarely exceeded 3.0 in any of our area-per-passenger buckets (As used here, "buckets" are a grouping of raw data into ranges.) No clear trend could be ascertained from the data. Perception values ranged from excellent (1) to very bad (5) for each function regardless of passenger space available.

Turning points were determined for four functional areas with regard to waiting time. In these, a clear trend in the data could be established, and the approximate waiting time where the average perception values went from acceptable to less than acceptable could be determined.

Table 7. Data collection process summary.

Functional Area	Data Collection Methodology	Sample Size (7 Airports)	
		Quantitative	Qualitative
Passenger check-in	• Passenger interview before and after queuing process • Ethnographic research	283 agent 61 curbside 580 kiosk 84 bag drop 1,008 Total	27
SSCP	• Passenger interview before and after queuing process • Ethnographic research	1,012	8
APM	• Passenger interview at arrival and when APM arrives • Ethnographic research	129	2
Corridor	• Passenger interview in transit • Ethnographic research	345	10
Holdroom	• Passenger interview upon arrival to holdroom and at boarding call • Ethnographic research	624	153
Bag claim	• Passenger interview at arrival and after bag claimed • Ethnographic research	861	42
Total		**3,979**	**242**

Table 8. Quantitative data collected at each airport by function.

Function	ATL	AUS	DFW	IAD	LAS	OAK	SDF	Total
Curbside	37	**	**	8	**	11	5	61
Check-in agent	48	27	142	**	43	23	**	283
Kiosk	123	106	43	137	44	38	89	580
Bag drop	4	53	**	15	12	**	**	84
SSCP	156	96	238	205	136	114	67	1,012
APM	18	*	96	**	15	*	*	129
Corridor	72	75	52	25	57	28	36	345
Holdroom	129	77	31	130	127	55	75	624
Bag claim	113	101	134	191	97	130	95	861
Total	**700**	**535**	**736**	**711**	**531**	**399**	**367**	**3,979**

*No APM at this airport
**No data collected

Table 9. Average perception ratings for each airport by function.

Function	ATL	AUS	DFW	IAD	LAS	OAK	SDF
Curbside	1.7	1.9	**	1.8	1.6	2.2	1.2
Check-in agent	2.7	2.6	2.1	**	2.7	1.9	**
Kiosk	2.1	1.6	1.4	2.2	2.2	1.7	2.3
Bag drop	1.4	2.2	**	2.4	2.3	**	**
SSCP	1.5	1.8	2.1	2	1.7	2.1	2.2
APM	1.6	*	1.4	*	1.5	*	*
Corridor	1.7	1.6	2.1	2.2	2.2	1.8	1.8
Holdroom	2.4	1.7	2.2	1.7	1.8	1.9	1.8
Bag claim	2	1.6	2.1	2.4	2.1	2.7	1.6

*No APM at this airport
**No data collected

Table 10. Average perception ratings by airport size.

Function	Small/Medium Airport Average Perception	Large Airport Average Perception	p-value	Significant Difference
Curbside	1.19	1.93	0.001	Yes
Ticketing	2.22	2.42	0.159	No
Kiosk	2.12	2.16	0.832	No
Bag drop	2.19	2.16	0.893	No
SSCP	1.99	1.89	0.310	No
Corridor	1.72	2.07	0.001	Yes
Holdroom	1.79	1.97	0.056	No
Bag claim	2.06	2.21	0.012	Yes

Table 11. Average perception ratings by function based on area per passenger.

Function	Area per Passenger (sq ft)					
	0–5	>5–10	>10–15	>15–20	>20–25	>25
Check-in agent	2.3	2.1	2.6	4.2	3.0	2.0
Kiosk	1.0	2.1	1.8	1.8	2.5	1.7
Bag drop	*	*	2.2	2.4	1.9	2.3
SSCP	2.1	2.8	2.3	2.0	1.9	2.0
APM	*	2.0	*	*	*	1.4
Corridor	*	*	*	*	*	1.9
Holdroom	*	4.0	1.6	1.8	2.3	1.9
Bag claim	*	*	*	2.1	2.3	2.2

*No data collected

Table 12. Average perception ratings by function based on wait time spent in process.

Function	Time Spent in Queue or Process (min)											
	0–5	>5–10	>10–15	>15–20	>20–25	>25–30	>30–35	>35–40	>40–45	>45–50	>50–55	>55–60
Curbside	1.5	2.1	2.3	*	*	*	*	*	*	*	*	*
Check-in agent	1.8	2.2	2.6	3.2	3.4	3.1	4.1	4.3	4.0	5.0	5.0	4.3
Kiosk	1.9	2.2	2.5	2.7	3.3	*	*	*	*	*	*	2.0
Bag drop	2.2	2.3	2.6	1.0	*	*	*	*	*	*	*	*
SSCP	1.8	2.4	2.6	1.0	*	2.0	3.6	3.5	*	*	*	2.0
Corridor	1.8	*	*	*	*	*	*	*	*	*	*	*
Holdroom	2.4	1.8	1.6	1.8	1.7	1.7	1.6	1.8	1.9	1.8	2.1	1.9
Bag claim	1.6	1.8	2.3	2.9	2.9	2.9	4.0	4.0	2.8	1.0	4.0	4.0

*No data collected

Table 13. Breakdown of data groups based on area per passenger.

Test Condition for Functional Area per Passenger	Data Group A	Data Group B
Condition 1	Area ≤ 5 sq ft per passenger	Area > 5 sq ft per passenger
Condition 2	Area ≤ 10 sq ft per passenger	Area > 10 sq ft per passenger
Condition 3	Area ≤ 15 sq ft per passenger	Area > 15 sq ft per passenger
Condition 4	Area ≤ 20 sq ft per passenger	Area > 20 sq ft per passenger

Table 14. Breakdown of data groups based on wait time.

Test Condition for Wait Time	Data Group A	Data Group B
Condition 1	Wait time ≤ 5 min	Wait time > 5 min
Condition 2	Wait time ≤ 10 min	Wait time > 10 min
Condition 3	Wait time ≤ 15 min	Wait time > 15 min
Condition 4	Wait time ≤ 20 min	Wait time > 20 min
Condition 5	Wait time ≤ 30 min	Wait time > 30 min

Table 15. Turning point by functional area and environmental factor.

Function	Area-per-Passenger TP	Passenger Wait-Time TP
Curbside	–	–
Check-in agent	–	More than 20 min
Kiosk	–	More than 20 min
Bag drop	–	–
SSCP	–	More than a value of between 10 to 30 min*
APM	–	–
Corridor	–	–
Holdroom	–	–
Bag claim	–	More than 20 min

*Lack of sufficient data in this range prevents a more definitive value for the TP.

First presented are the detailed results for the four functional areas (staffed agent check-in, kiosk, SSCP, and bag claim) where it was possible to discern legitimate turning points in the data for passenger wait times where the average perception values rose above acceptable (3.0). The remaining functional areas (where no legitimate turning points could be developed) are shown in Appendix B.

Detailed Passenger Wait-Time Results

Figures 1 through 8 show the graphical spread of the data collected for all airports for wait times, both in terms of the raw data and averages of 5-min time buckets (e.g., 0–5 min, >5–10 min). Five-minute periods were chosen as the level of resolution because smaller periods did not contain enough data points across the board to conduct relevant statistical tests. Larger periods would not provide as much resolution. The data show the relationship between perception score and the time spent in queue or process for a given functional area for the four areas that exhibited a clear trend.

Check-In

Table 16 shows the average perception rating depending on how long the passengers spent in the queue.

Table 16. Average passenger perception of ticketing queue time versus length of wait.

Length of Wait	Average Perception
0–5 min	1.8
>5–10 min	2.2
>10–15 min	2.6
>15–20 min	3.2
>20–25 min	3.7
>25–30 min	3.2
>30–35 min	4.0

Figure 1 shows the spread of perception data, and Figure 2 shows the distribution of average perception ratings for the agent check-in process collected at all airports compared to waiting time. Each X represents at least one data point.

For Figure 2, the size of the bubble shows the relative number of data points that make up the average for that bucket compared to other buckets.

Table 17 shows the results for the test conditions for this functional area based on waiting time. Statistical analysis shows the relationship between time in queue and average perception rating to be significant for each test condition (1 through 5) for waiting time. This indicates a progressive relationship between time spent waiting and average perception rating. If we determine the point at which average perception passes the acceptable ranking (3), we obtain the turning point. For these data, the TP occurs around a wait time of 16 to 20 min.

Kiosks

Table 18 shows the average perception rating depending on the number of minutes each passenger spent waiting at the kiosk.

Figure 3 shows the spread of perception data, and Figure 4 shows the distribution of average perception ratings for the kiosk process collected at all airports compared to waiting time. Each X represents at least one data point.

For Figure 4, the size of the bubble shows the relative number of data points that make up the average for that bucket compared to the other buckets.

Table 19 shows the results for the test conditions for this functional area based on waiting time. Statistical analysis shows the relationship between time in queue and average perception rating to be significant for the first four test conditions (1 through 4) for waiting time. This indicates a progressive relationship between the time spent waiting and average perception rating. If we determine the point at which average

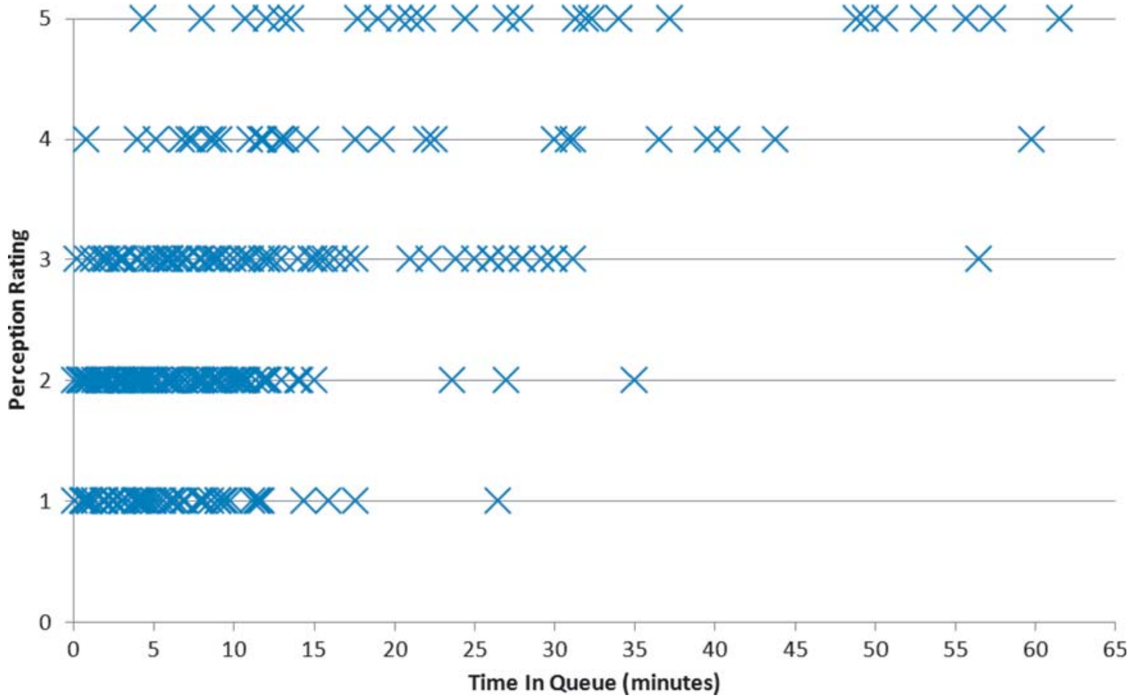

Figure 1. Perception ratings for staffed agent check-in process by time spent in queue.

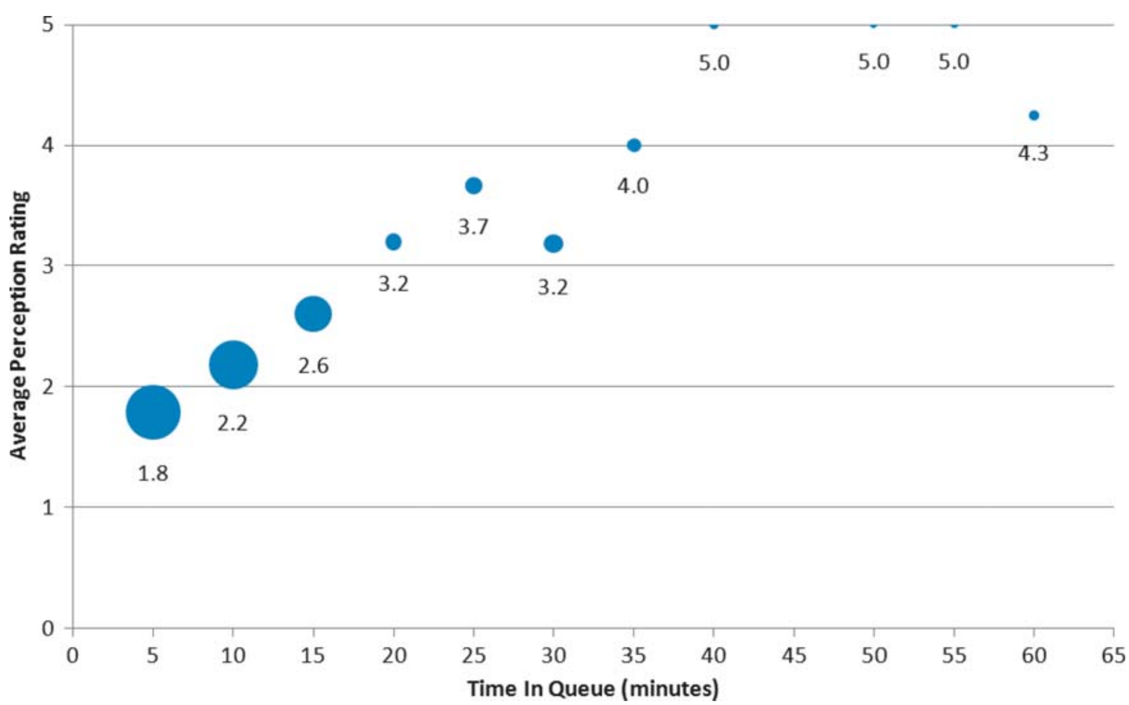

Figure 2. Average perception ratings for staffed agent check-in process by time spent in queue.

Table 17. Results for test conditions for staffed agent check-in based on waiting time.

Test Condition for Wait Time	Data Group A	Data Group B	p-value	Significant Difference
Condition 1	Wait Time ≤ 5 min	Wait Time > 5 min	0.00	Yes
Condition 2	Wait Time ≤ 10 min	Wait Time > 10 min	0.00	Yes
Condition 3	Wait Time ≤ 15 min	Wait Time > 15 min	0.00	Yes
Condition 4	Wait Time ≤ 20 min	Wait Time > 20 min	0.00	Yes
Condition 5	Wait Time ≤ 30 min	Wait Time > 30 min	0.00	Yes

Table 18. Average passenger perception of kiosk process time versus length of wait.

Length of Wait	Average Perception
0–5 min	2.0
>5–10 min	2.4
>10–15 min	2.6
>15–20 min	2.7
>20–25 min	3.2

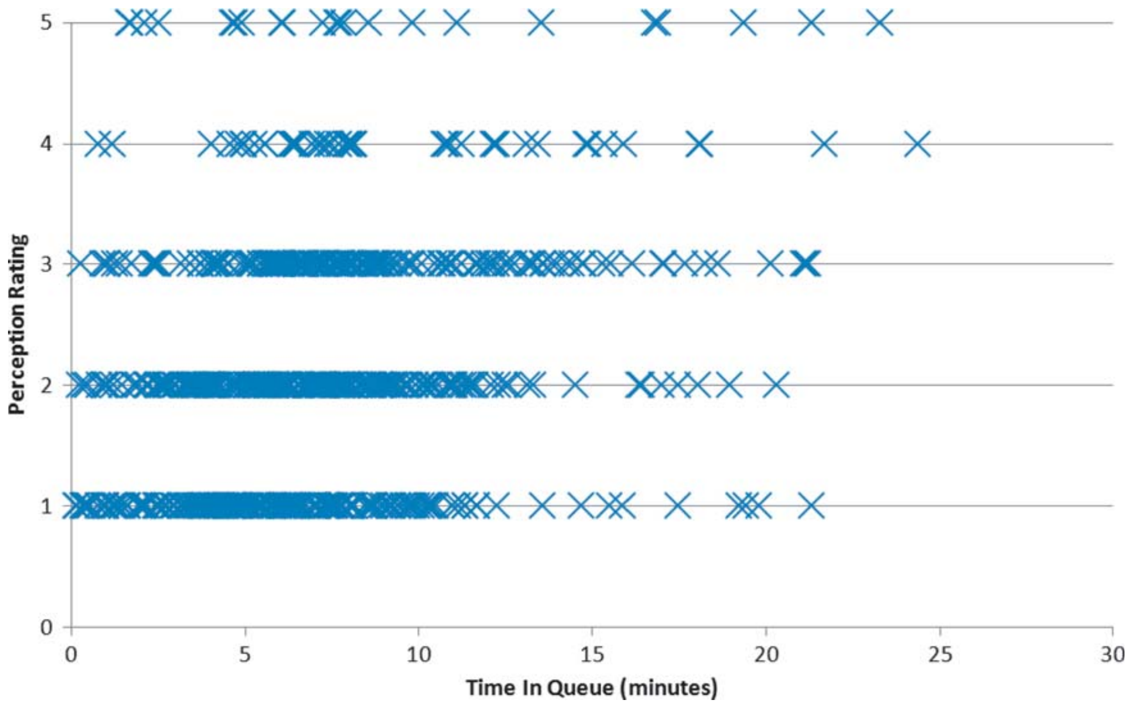

Figure 3. Perception ratings for kiosk process by time spent in queue.

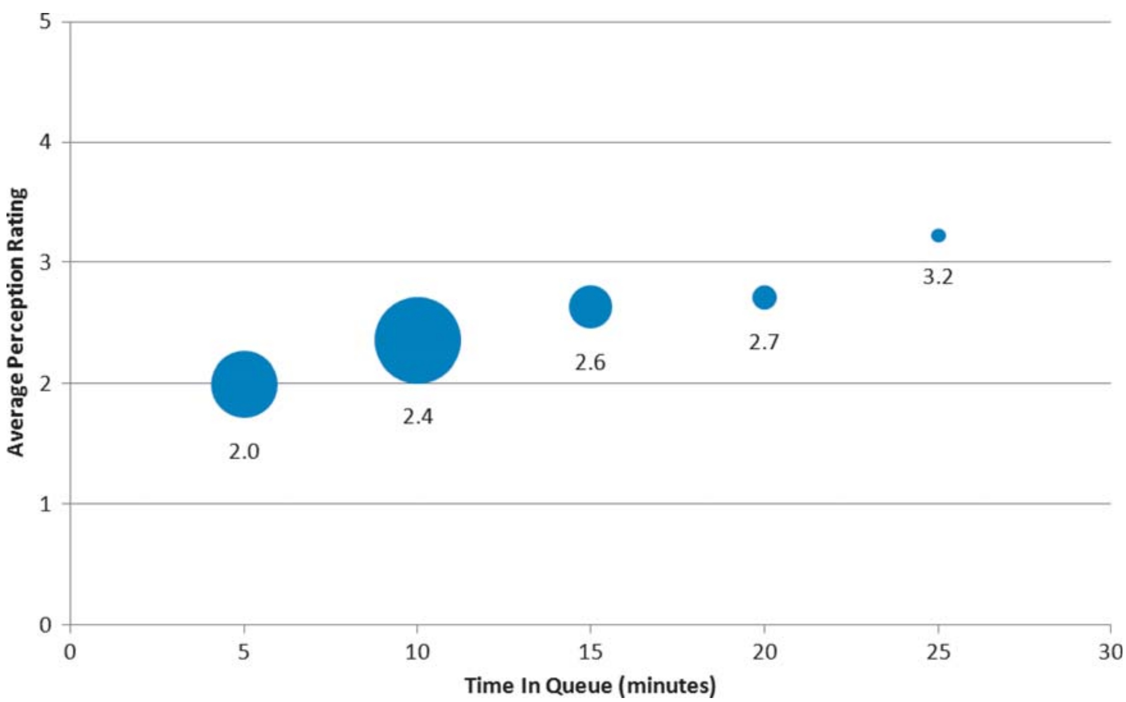

Figure 4. Average perception ratings for kiosk process by time spent in queue.

Table 19. Results for test conditions for kiosk based on waiting time.

Test Condition for Wait Time	Data Group A	Data Group B	p-value	Significant Difference
Condition 1	Wait time ≤ 5 min	Wait time > 5 min	0.00	Yes
Condition 2	Wait time ≤ 10 min	Wait time > 10 min	0.00	Yes
Condition 3	Wait time ≤ 15 min	Wait time > 15 min	.006	Yes
Condition 4	Wait time ≤ 20 min	Wait time > 20 min	.030	Yes
Condition 5	Wait time ≤ 30 min	Wait time > 30 min	.656	No

perception passes the acceptable ranking (3), we obtain the TP. For these data, the TP occurs within a wait time of 21 to 25 min.

Security Screening Checkpoint

Table 20 shows the average perception rating depending on how long the passengers were in the checkpoint queue.

Figure 5 shows the spread of perception data, and Figure 6 shows the distribution of average perception ratings for the SSCP process collected at all airports compared to waiting time. Each X represents at least one data point.

For Figure 6, the size of the bubble shows the relative number of data points that make up the average for that bucket compared to the other buckets. There was a noticeable lack of data past the 10- to 12-minute mark—an indication that such conditions occur infrequently in practice, given the TSA's focus on providing shorter wait times for passengers during the study time frame.

Table 20. Average passenger perception of security queue time versus length of wait.

Length of Wait	Average Perception
0–5 min	1.8
>5–10 min	2.4
>10–15 min	2.6

Table 21 shows the results for the test conditions for this functional area based on waiting time. Statistical analysis shows the relationship between time in queue and average perception rating to be significant for each test condition (1 through 5) for waiting time. This indicates a progressive relationship between time spent waiting and average perception rating. If we determine the point at which average perception exceeds the acceptable ranking (3), we obtain the TP. For these data, the TP likely occurs around a wait time of above 10 min.

Bag Claim

Table 22 shows the average perception rating depending on how long the passengers spent in the bag claim process.

Figure 7 shows the spread of perception data, and Figure 8 shows the distribution of average perception ratings for the bag claim process collected at all airports compared to waiting time. Each X represents at least one data point.

For Figure 8, the size of the bubble shows the relative number of data points that make up the average for that bucket compared to the other buckets.

Table 23 shows the results for the test conditions for this functional area based on waiting time. Statistical analysis shows the relationship between time in queue and average perception rating to be significant for all five test conditions (1 through 5) for waiting time. This indicates a progressive relationship between time spent waiting and average perception rating. If we determine the point at which average perception passes

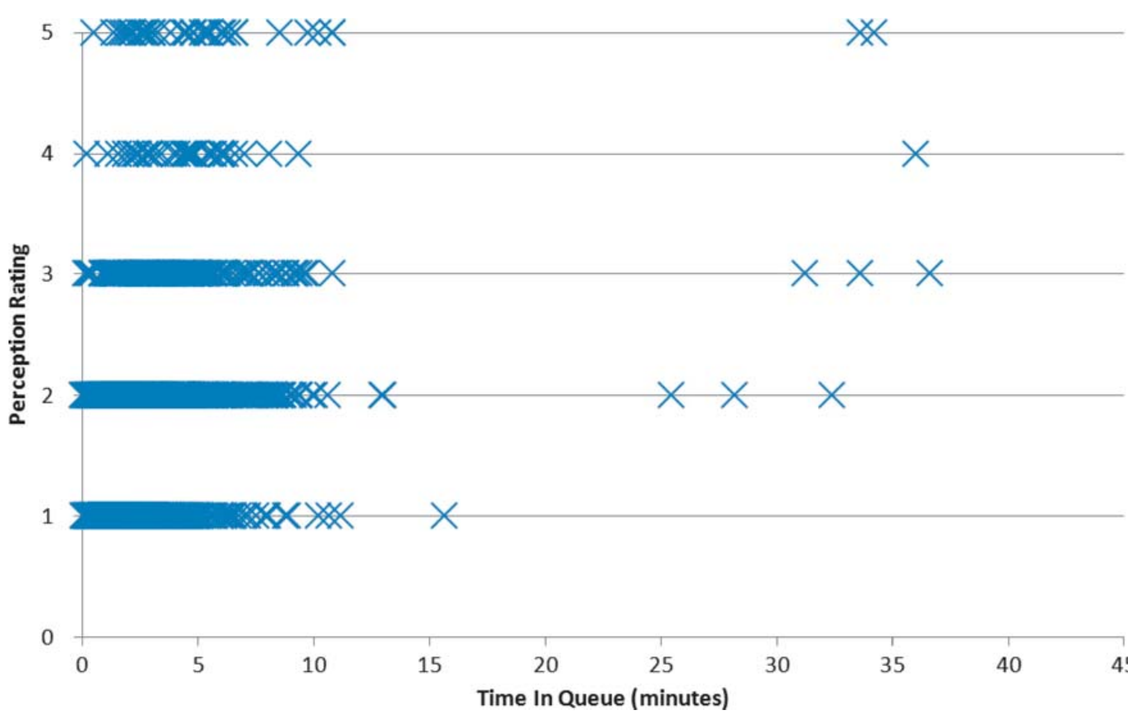

Figure 5. Perception ratings for SSCP process by time spent in queue.

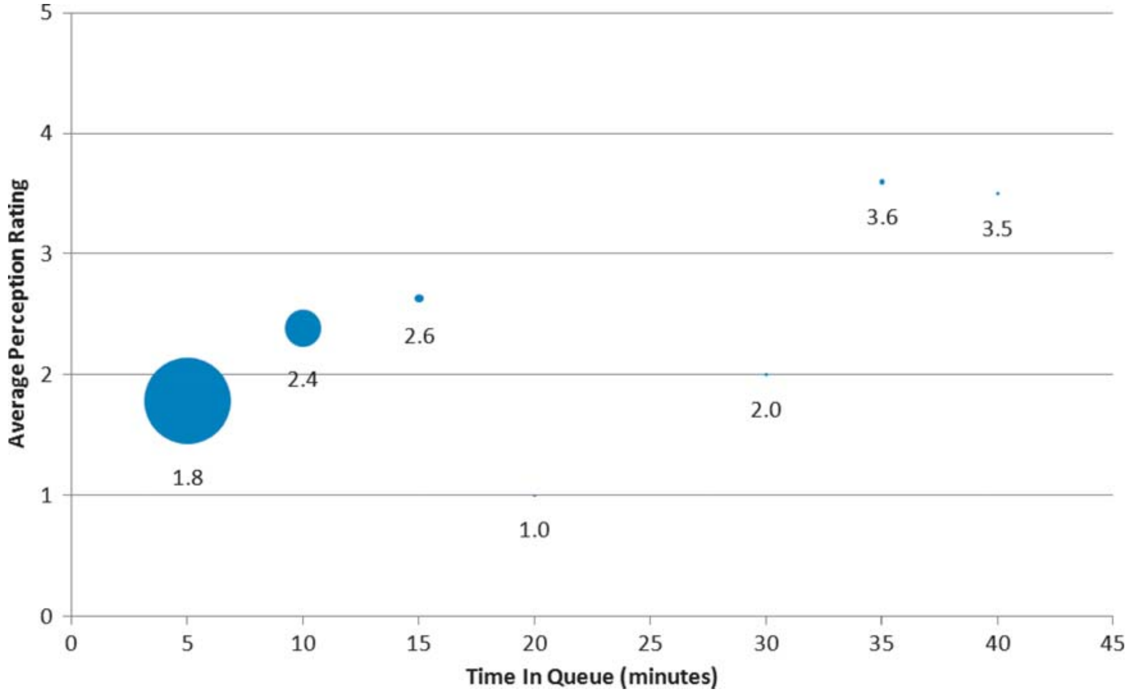

Figure 6. Average perception ratings for SSCP process by time spent in queue.

Table 21. Results for test conditions for SSCP based on waiting time.

Test Condition for Wait Time	Data Group A	Data Group B	p-value	Significant Difference
Condition 1	Wait time ≤ 5 min	Wait time > 5 min	0.00	Yes
Condition 2	Wait time ≤ 10 min	Wait time > 10 min	0.00	Yes
Condition 3	Wait time ≤ 15 min	Wait time > 15 min	0.00	Yes
Condition 4	Wait time ≤ 20 min	Wait time > 20 min	0.00	Yes
Condition 5	Wait time ≤ 30 min	Wait time > 30 min	0.00	Yes

Table 22. Average passenger perception of bag claim process time versus length of wait.

Length of Wait	Average Perception
0–5 min	1.6
>5–10 min	1.8
>10–15 min	2.3
>15–20 min	2.9
>20–25 min	2.9
>25–30 min	2.9
>30–35 min	4.0

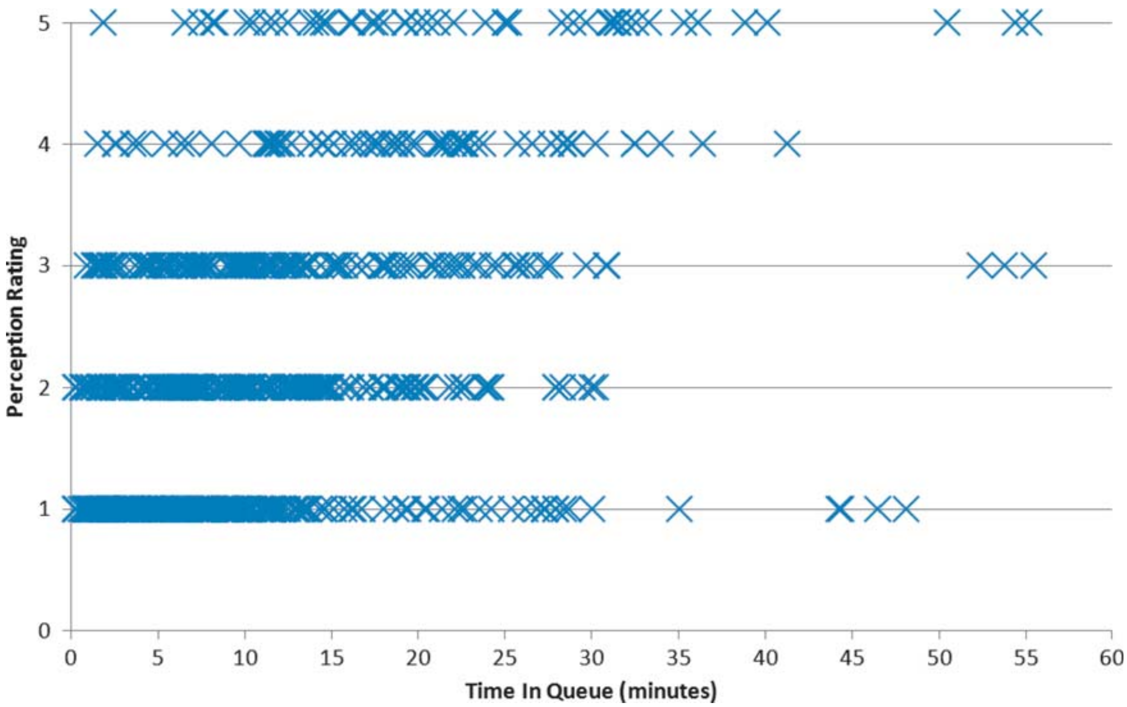

Figure 7. Perception ratings for bag claim process by time spent in queue.

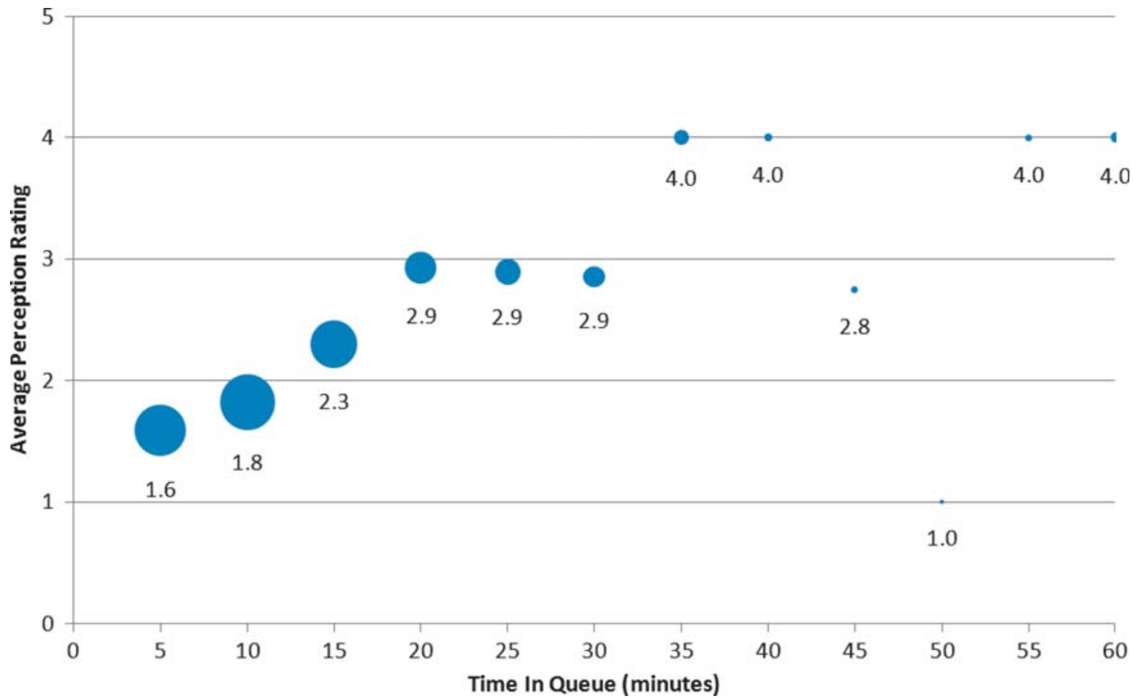

Figure 8. Average perception ratings for bag claim process by time spent in queue.

the acceptable ranking (3), we can obtain the TP. For these data, the TP occurs between a wait time of 20 and 25 min—interestingly, approximately the length of time that most airline passengers wait for their bags in today's airports, which is about 5 to 10 min longer than in previous years.

Detailed Passenger Density Results

This section discusses the detailed passenger density results. Shown are the same results for area as previously shown for time. Where turning points were identified in the waiting-time graphs presented previously, note the absence of similar relationships in the area-per-passenger graphs presented here. Figures 9 through 18 show the graphical spread of the data collected for all airports for area per passenger, both in terms of the raw data and averages of 5 sq ft per passenger area buckets (e.g., 0–5 sq ft per passenger, 5–10 sq ft per passenger). Increments of 5 sq ft were used since this would facilitate comparison to existing Fruin and IATA passenger perception frameworks. The data show the relationship between perception score and the amount of area available for each passenger for a given functional area. For the graphs that show averages, the size of the bubble shows the relative number of data points that make up the average for that bucket compared to the other buckets. Except in a few cases described herein, there does not appear to be a significant correlation between area per passenger and average perception.

Check-in

Passengers were interviewed prior to joining the queue in front of the check-in facility. They were asked

- How many people are in the traveling party?
- How many bags are you checking?
- How many carts are you using?

Table 23. Results for test conditions for bag claim based on waiting time.

Test Condition for Wait Time	Data Group A	Data Group B	p-value	Significant Difference
Condition 1	Wait time ≤ 5 min	Wait time > 5 min	0.00	Yes
Condition 2	Wait time ≤ 10 min	Wait time > 10 min	0.00	Yes
Condition 3	Wait time ≤ 15 min	Wait time > 15 min	0.00	Yes
Condition 4	Wait time ≤ 20 min	Wait time > 20 min	0.00	Yes
Condition 5	Wait time ≤ 30 min	Wait time > 30 min	0.00	Yes

Table 24. Average passenger perception of ticketing queue versus area per passenger.

Area per Passenger (sq ft)	Average Perception
15–20	4.8
>20–25	3.0
>25–30	1.7
>30–35	3.0
>35–40	2.7
>40–45	2.0
>45–50	n/a
>50–55	1.3
>55–60	2.0

- Is your trip primarily for business or leisure purposes?
- Is your trip to a domestic or international location?

Additionally, the data collector noted the number of passengers in the queue, the time of the observation, and the approximate length of the queue based on the position of the end of the queue relative to the check-in lobby configuration. For all areas observed, the queue length grew proportionally to the number of passengers in queue (roughly 3.3. linear feet per passenger) and would overflow the designated area as the queue grew. Table 24 shows the average perception rating depending on the check-in queue area. Note that there is no relationship between more space per passenger and perception of higher LOS.

Figure 9 shows the spread of perception data, and Figure 10 shows the distribution of average perception ratings for the agent check-in process collected at all airports compared to average passenger area. Each X represents at least one data point.

Table 25 shows the results for the test conditions for this functional area based on area per passenger. Statistical analysis fails to show a significant difference between area per passenger and average perception rating for four test conditions (1 through 4) since there were not enough applicable data. No TP is indicated for these data.

Kiosks

The passengers' time of arrival and the number of passengers in process in the area were determined by examining video documentation of the area for DFW and by the two-person time-stamp method for all other airports. Table 26 shows the average perception rating depending on how many passengers were in the kiosk area.

Figure 11 shows the spread of perception data, and Figure 12 shows the distribution of average perception ratings for the kiosk process collected at all airports compared to average passenger area. Each X represents at least one data point.

Table 27 shows the results for the test conditions for this functional area based on area per passenger. Statistical analysis fails to show a significant difference between area per passenger and average perception rating for four test conditions (1 through 4). This indicates no definable relationship between area per passenger and average perception rating

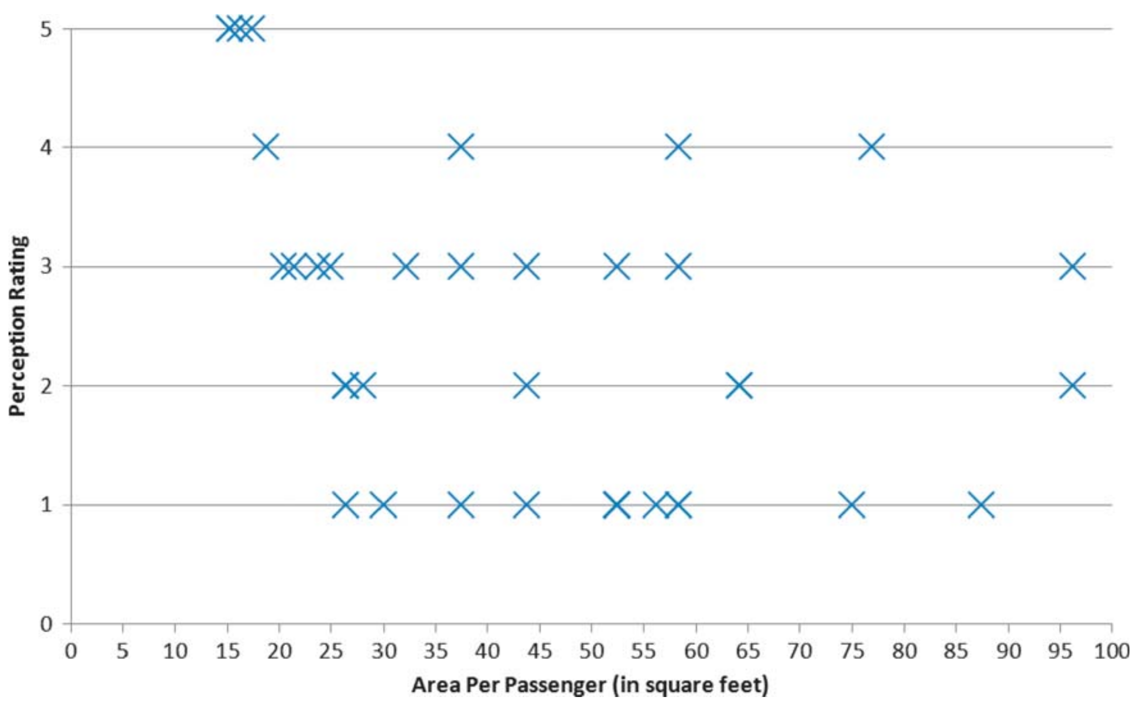

Figure 9. Perception ratings for agent check-in process by area per passenger.

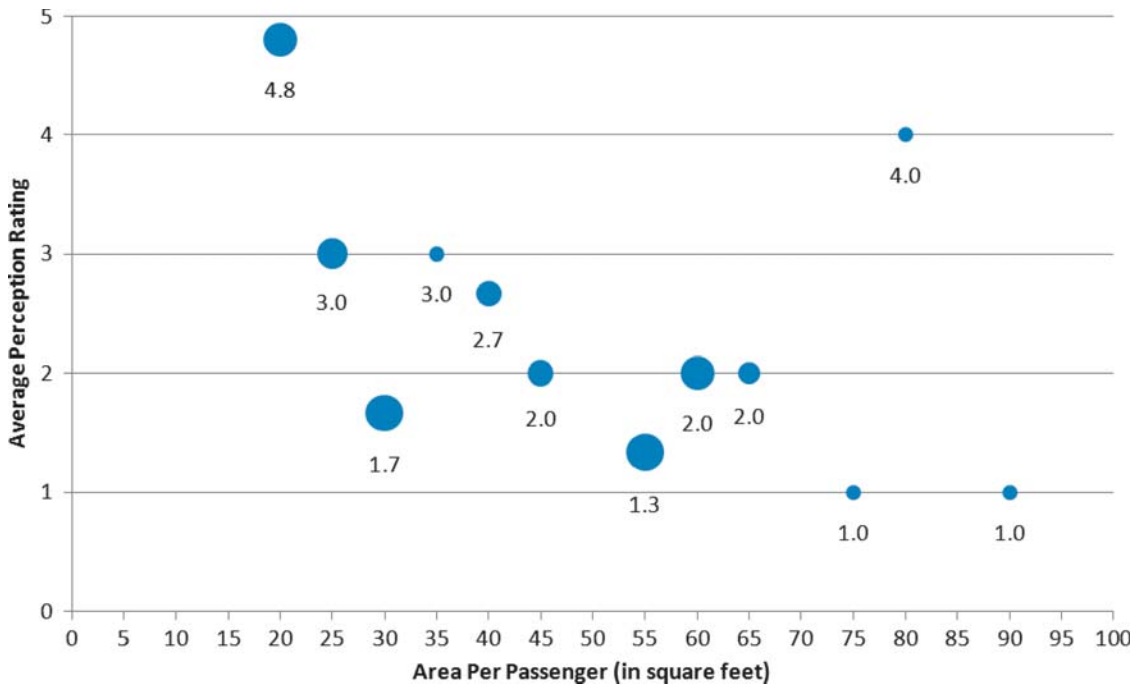

Figure 10. Average perception ratings for agent check-in process by area per passenger.

Table 25. Results for test conditions for agent check-in based on area per passenger.

Test Condition for Area	Data Group A	Data Group B	p-value	Significant Difference
Condition 1	Area ≤ 5 sq ft per passenger	Area > 5 sq ft per passenger	–	No data
Condition 2	Area ≤ 10 sq ft per passenger	Area > 10 sq ft per passenger	–	No data
Condition 3	Area ≤ 15 sq ft per passenger	Area > 15 sq ft per passenger	–	No data
Condition 4	Area ≤ 20 sq ft per passenger	Area > 20 sq ft per passenger	–	Inadequate data

for this function. Additionally, for all area buckets the average perception rating generally remains better than acceptable (less than 3.0). No TP is indicated for these data.

Security Screening Checkpoint

Passengers were interviewed prior to joining the queue in front of the ID check at the security checkpoint. They were asked

- Is your trip primarily for business or leisure purposes?
- Is your trip to a domestic or international location?

Additionally, the data collector noted the number of passengers in the queue, the time of the observation, and the approximate length of the queue based on the position of the end of the queue relative to the SSCP configuration. For all areas observed, the queue length grew proportionally to the number of passengers in queue (approximately 2.2 linear feet per passenger) and would spill out of the designated area as the queue grew.

Table 28 shows the average perception rating depending on how many passengers were in the queue.

Figure 13 shows the spread of perception data, and Figure 14 shows the distribution of average perception ratings for the SSCP process collected at all airports compared to

Table 26. Average passenger perception of kiosk process versus area per passenger.

Area per Passenger (sq ft)	Average Perception
0–5	n/a
>5–10	2.1
>10–15	1.8
>15–20	1.8
>20–25	2.5
>25–30	n/a
>30–35	2.2
>35–40	2.0
>40–45	1.9
>45–50	2.1
>50–55	2.0
>55–60	1.5

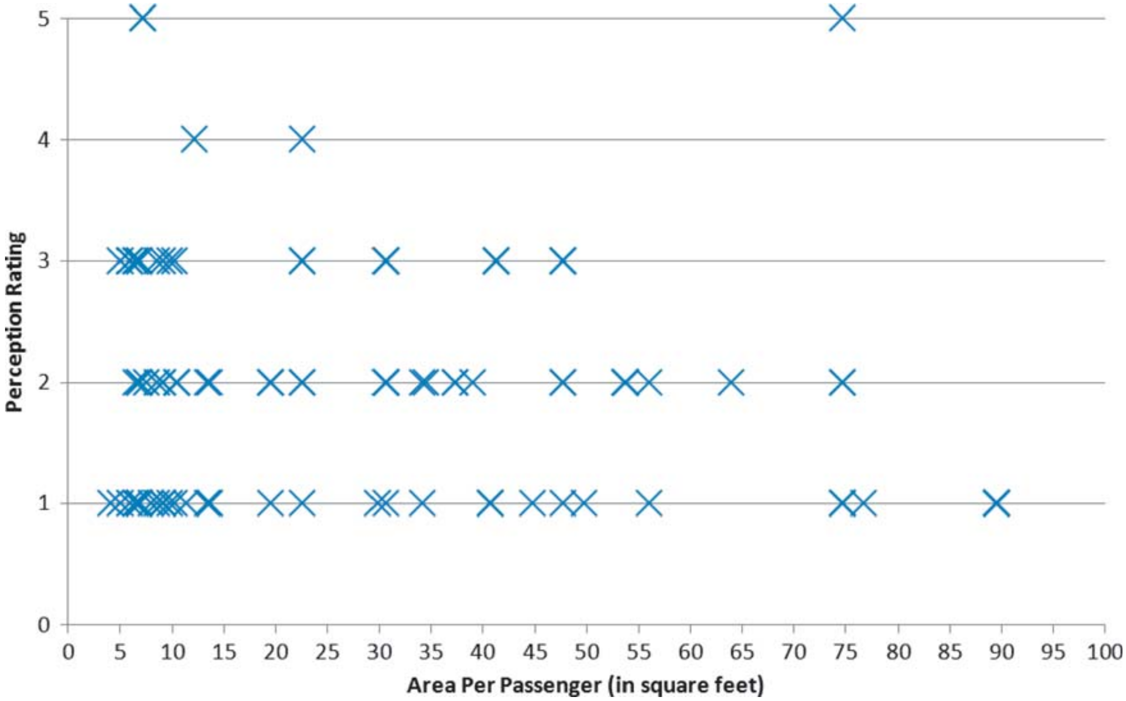

Figure 11. Perception ratings for kiosk process by area per passenger.

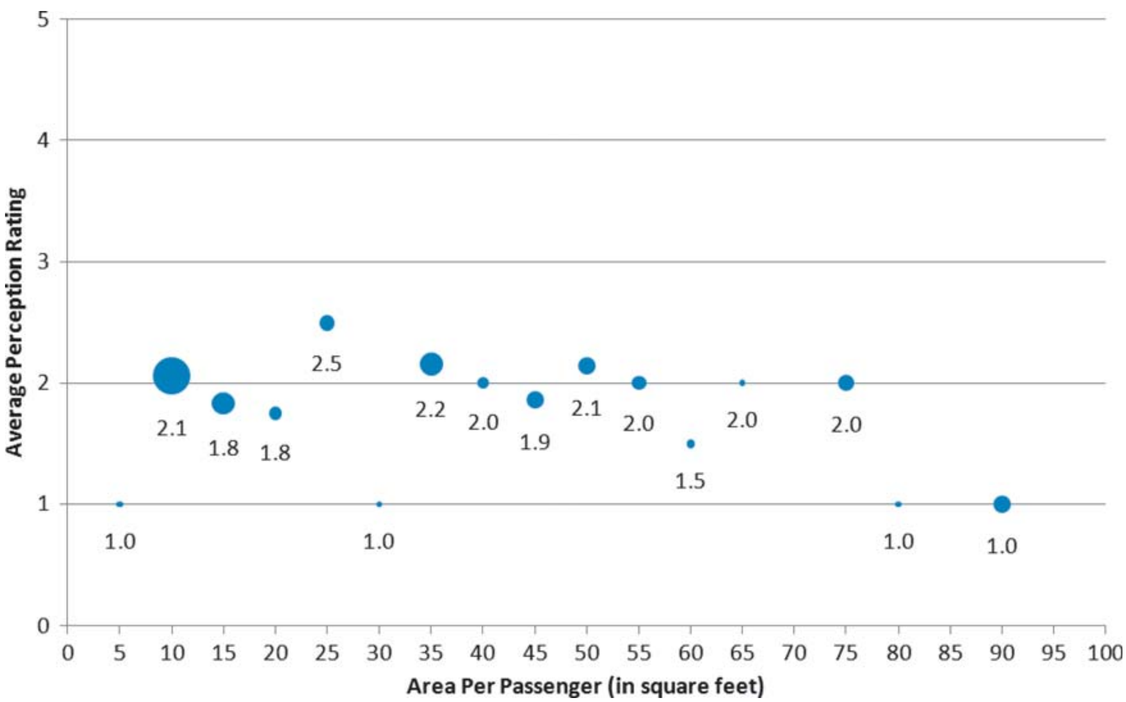

Figure 12. Average perception ratings for kiosk process by area per passenger.

Table 27. Results for test conditions for kiosk based on area per passenger.

Test Condition for Area	Data Group A	Data Group B	p-value	Significant Difference
Condition 1	Area ≤ 5 sq ft per passenger	Area > 5 sq ft per passenger	.380	No
Condition 2	Area ≤ 10 sq ft per passenger	Area > 10 sq ft per passenger	.190	No
Condition 3	Area ≤ 15 sq ft per passenger	Area > 15 sq ft per passenger	.241	No
Condition 4	Area ≤ 20 sq ft per passenger	Area > 20 sq ft per passenger	.280	No

Table 28. Average passenger perception of security queue versus area per passenger.

Area per Passenger (sq ft)	Average Perception
5–10	2.4
>10–15	2.3
>15–20	2.0
>20–25	1.9
>25–30	1.9
>30–35	n/a
>35–40	2.3
>40–45	1.3
>45–50	1.7
>50–55	1.9
>55–60	1.9

average passenger area. Each X represents at least one data point.

Table 29 shows the results for the test conditions for this functional area based on area per passenger. Statistical analysis fails to show a significant difference between area per passenger and average perception rating for two of the four test conditions (1 and 2) because sufficient data were not available, but the results show a significant difference for the test conditions 3 and 4. However, for all buckets the average perception rating remains better than acceptable (less than 3.0) so no TP is indicated for these data.

Holdrooms

Passengers were intercepted in the holdroom and asked to rate their holdroom experience on a scale of 1 to 5. They were also asked

- Is your trip primarily for business or leisure purposes?
- Is your trip to a domestic or international location?

Video evidence was used to determine the number of passengers in the holdroom area at the time of the observation for DFW and by the two-person time-stamp method for all other airports. Table 30 shows the average perception rating depending on how many passengers were in the holdroom.

Figure 15 provides an example of the spread of perception data for one processor—holdrooms. Each X represents at least one data point. It is important to note that there are many instances of poor perception ratings (>3) associated with very low passenger density (more than 15 sq ft per passenger—IATA LOS A).

Figure 16 shows the distribution of average perception ratings for the holdroom process collected at all airports compared to average passenger area. For Figure 16, the size of the bubble shows the relative number of data points that make up the average for that bucket compared to the other buckets.

Table 31 shows the results for the test conditions for this functional area based on area per passenger. Statistical analy-

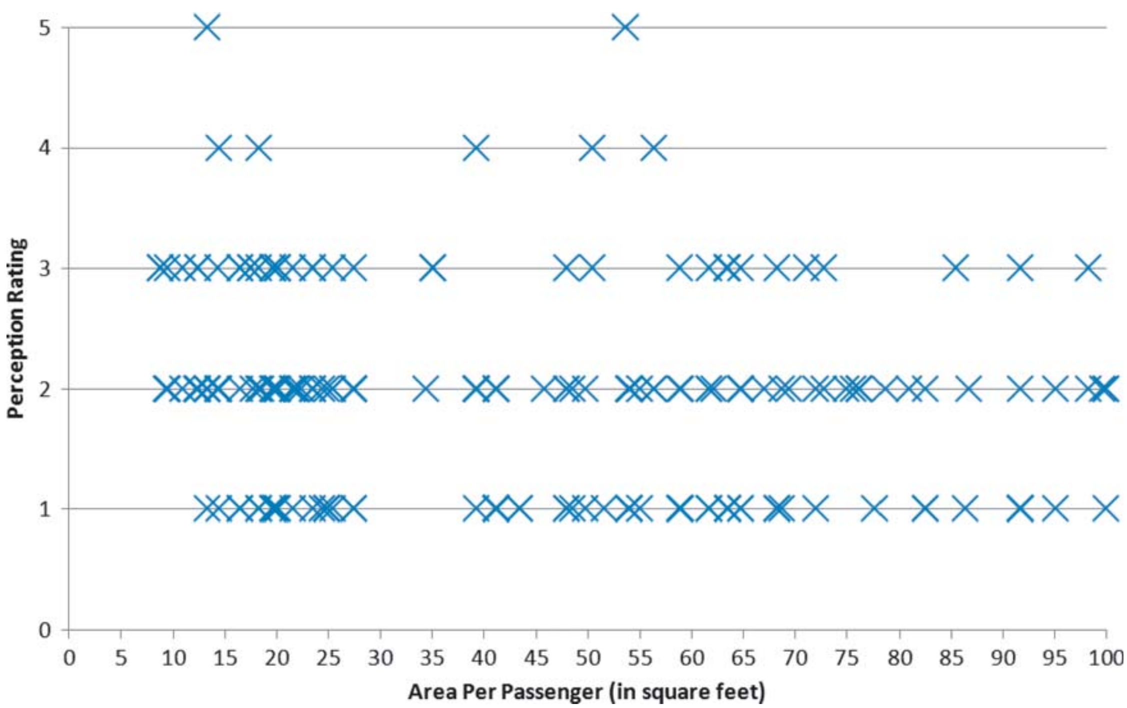

Figure 13. Perception ratings for SSCP process by area per passenger.

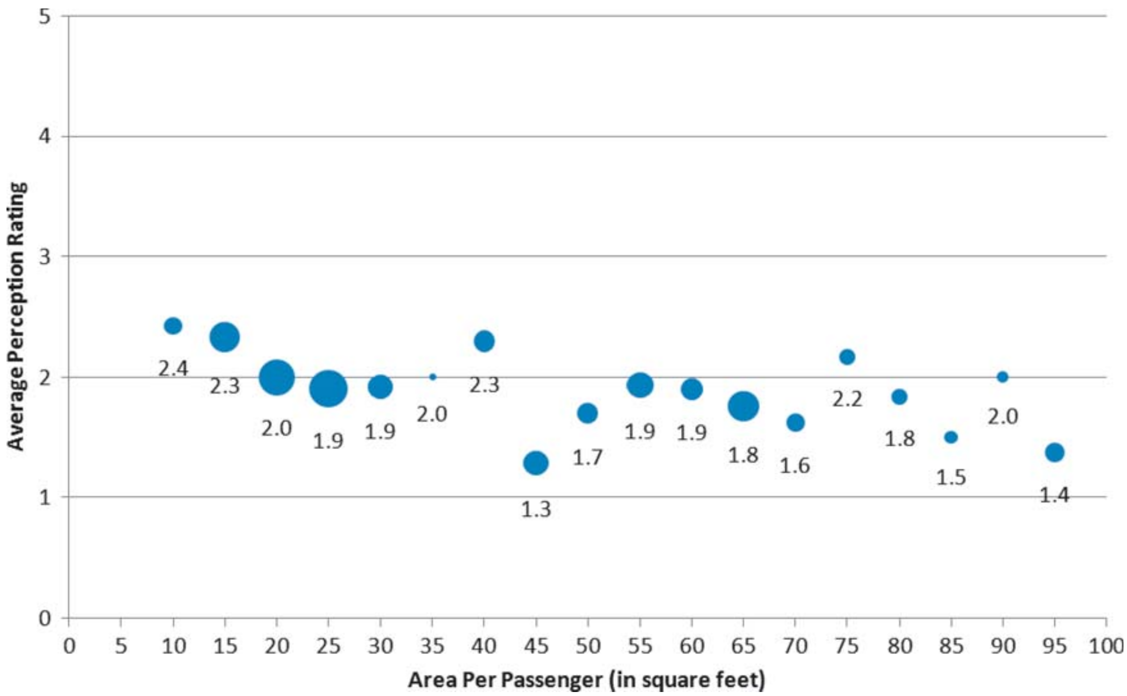

Figure 14. Average perception ratings for SSCP process by area per passenger.

Table 29. Results for test conditions for SSCP based on area per passenger.

Test Condition for Area	Data Group A	Data Group B	p-value	Significant Difference
Condition 1	Area ≤ 5 sq ft per passenger	Area > 5 sq ft per passenger	–	No data
Condition 2	Area ≤ 10 sq ft per passenger	Area > 10 sq ft per passenger	–	Inadequate data
Condition 3	Area ≤ 15 sq ft per passenger	Area > 15 sq ft per passenger	.025	Yes
Condition 4	Area ≤ 20 sq ft per passenger	Area > 20 sq ft per passenger	.034	Yes

sis fails to show a significant difference between area per passenger and average perception rating for two of the four test conditions (3 and 4), and sufficient data were not available for the first two test conditions. The average perception of 4.0 at 10 sq ft represents only a few data points.

Table 30. Average passenger perception of holdroom experience versus area per passenger.

Area per Passenger (sq ft)	Average Perception
10–15	1.6
>15–20	1.8
>20–25	2.3
>25–30	1.5
>30–35	3.1
>35–40	2.4
>40–45	1.8
>45–50	1.5
>50–55	1.7
>55–60	1.7

Baggage Claim

Passengers were intercepted at the end of their bag claim process and asked to rate their bag claim experience on a scale from 1 to 5. They were additionally asked

- Is your trip primarily for business or leisure purposes?
- Is your trip to a domestic or international location?

Video evidence was used to determine the number of passengers in the bag claim area at the time of the observation for DFW and by the two-person time-stamp method for all other airports. Table 32 shows the average perception rating depending on how many passengers were in the bag claim area.

Figure 17 shows the spread of perception data, and Figure 18 shows the distribution of average perception ratings for the bag claim process collected at all airports compared to average passenger area. Each X represents at least one data point.

Table 33 shows the results for the test conditions for this functional area based on area per passenger. Statistical analysis

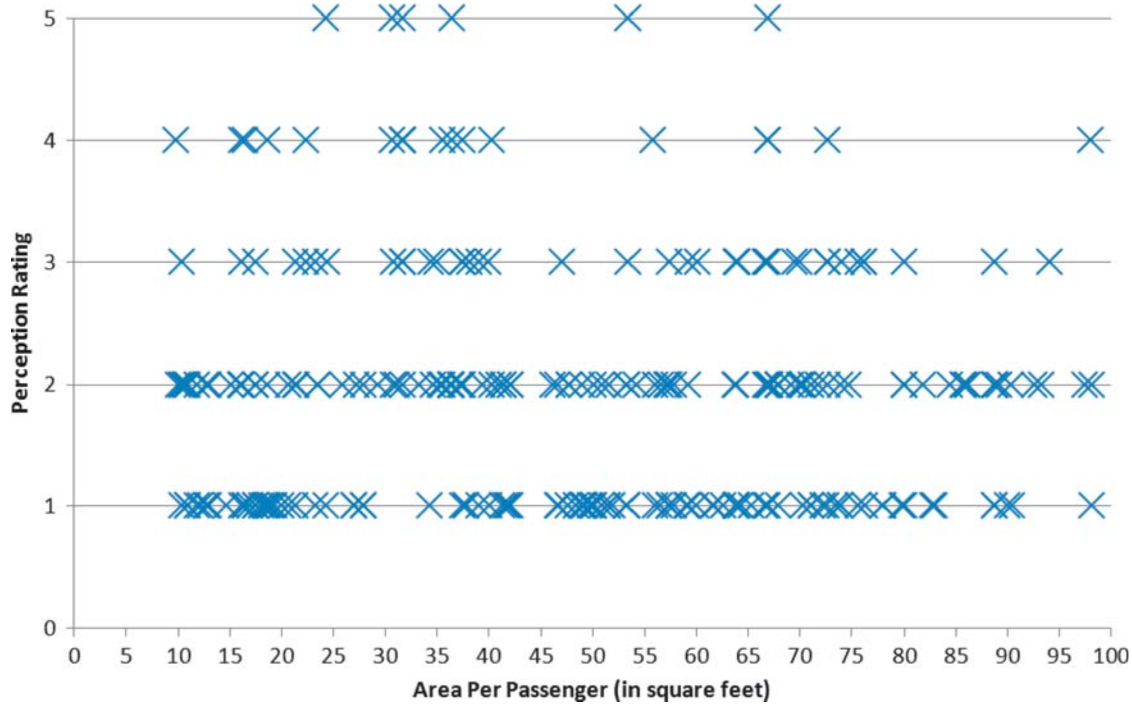

Figure 15. Perception ratings for holdroom process by area per passenger.

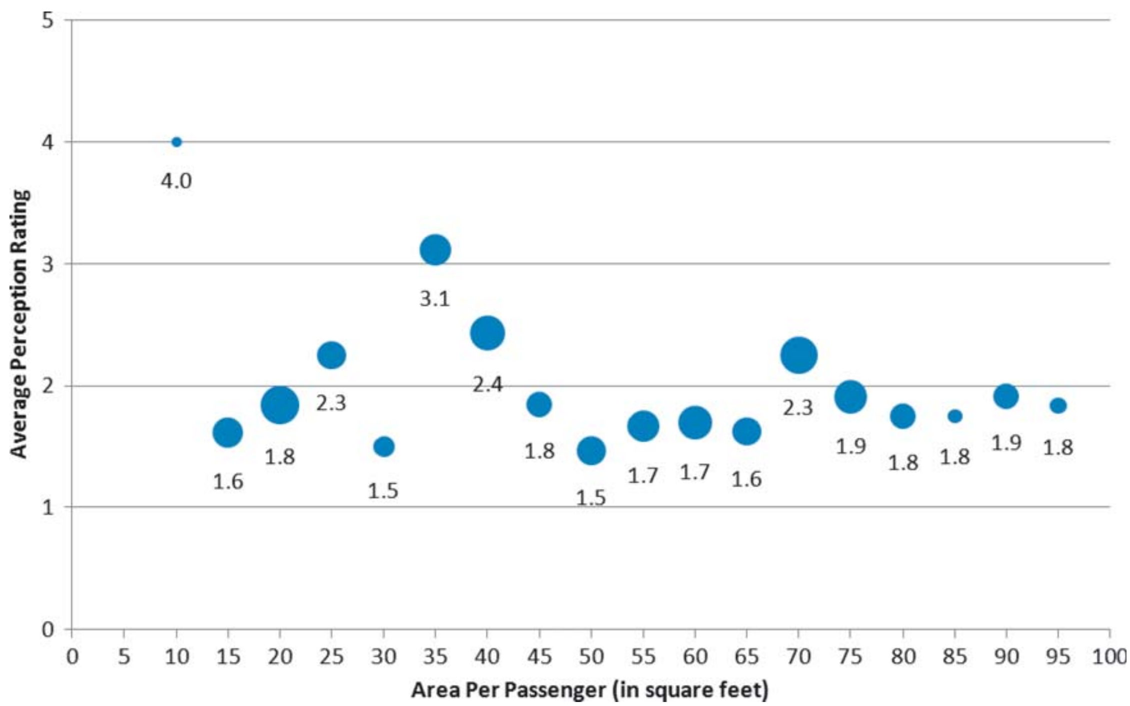

Figure 16. Average perception ratings for holdroom process by area per passenger.

Table 31. Results for test conditions for holdroom based on area per passenger.

Test Condition for Area	Data Group A	Data Group B	p-value	Significant Difference
Condition 1	Area ≤ 5 sq ft per passenger	Area > 5 sq ft per passenger	–	No data
Condition 2	Area ≤ 10 sq ft per passenger	Area > 10 sq ft per passenger	–	Inadequate data
Condition 3	Area ≤ 15 sq ft per passenger	Area > 15 sq ft per passenger	.440	No
Condition 4	Area ≤ 20 sq ft per passenger	Area > 20 sq ft per passenger	.432	No

Table 32. Average passenger perception of baggage claim experience versus area per passenger.

Area per Passenger (sq ft)	Average Perception
15–20	2.1
>20–25	2.3
>25–30	2.6
>30–35	2.4
>35–40	n/a
>40–45	2.4
>45–50	2.0
>50–55	2.4
>55–60	1.6

fails to show a significant difference between area per passenger and average perception rating for the fourth test condition (4). There were no data available for the first three conditions (1 through 3), but a relationship could exist if the data could be collected for that region. Additionally, for all area buckets, the average perception rating generally remains better than acceptable (less than 3.0). No TP is indicated for these data.

Passenger Perceptions Associated with Air Service Categories

To determine if the average perception data showed significant differences based on the other information collected, the data were grouped for various test conditions for each of the factors of interest: purpose of trip, destination or arrival market, and airline type. Table 34 shows the data groupings for each test condition.

Table 35 shows the breakdown between business and leisure passenger average perception ratings for each of the functional group data sets. However, none of the functional groupings indicated statistically significant differences between the perception averages. Therefore, we could not discern any impact that trip purpose had on passenger perception rating. This finding is consistent with work reported by Seneviratne and Martel in 1991 (*5*).

Table 36 shows the breakdown between domestic and international passenger average perception ratings for each of the functional group data sets. Only the SSCP areas and holdrooms indicated statistically significant differences between the perception averages.

Table 37 shows the breakdown of airline by type. Legacy carriers are airlines such as American, Continental, and Delta. Low-cost carriers are those such as Southwest and Jet Blue.

Due to sample size and other factors, only the bag claim, curbside, and holdroom functions showed statistically significant differences in mean perception ratings between these types of carriers. Table 38 shows the perception data by the airline type.

Qualitative (Ethnographic) Results

Table 39 shows the overall tally of responses from the qualitative study for general categories of interest. Note that a passenger could contribute more than one comment. We have highlighted the top five response categories for each comment type for clarity.

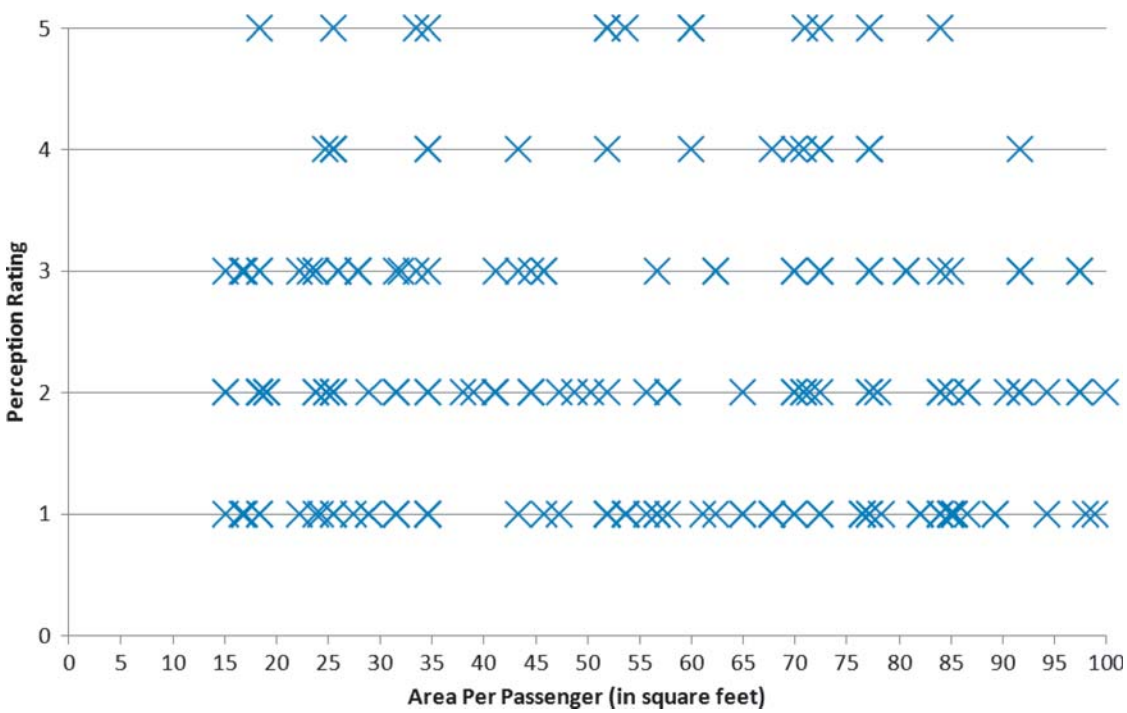

Figure 17. Perception ratings for bag claim process by area per passenger.

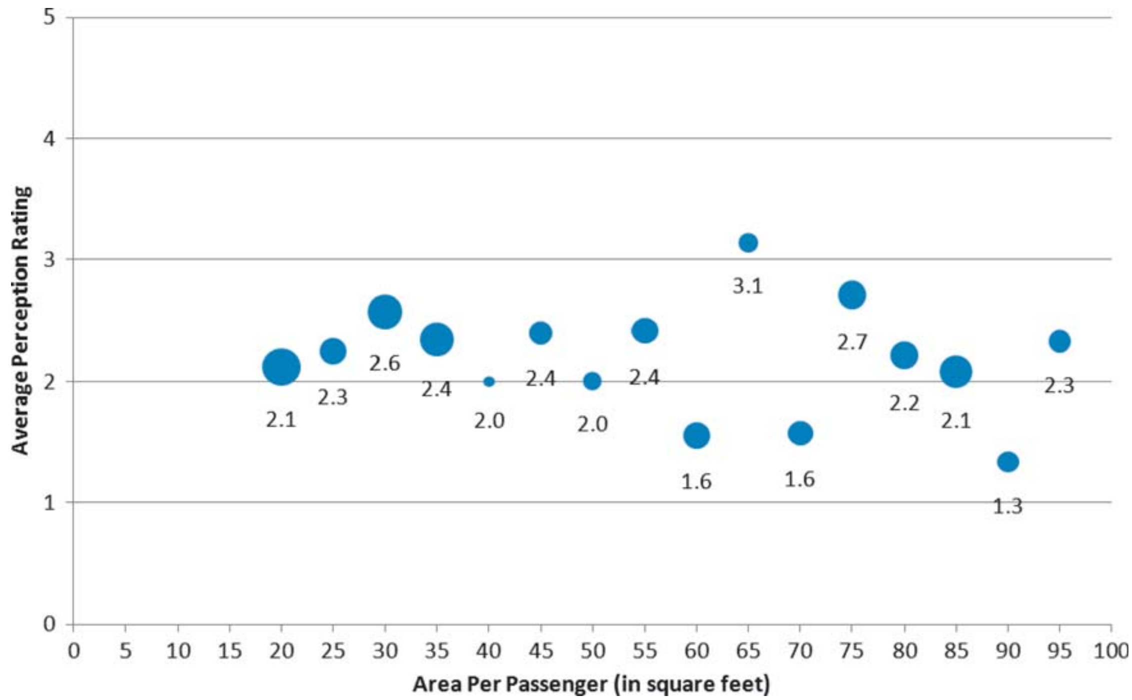

Figure 18. Average perception ratings for bag claim process by area per passenger.

Table 33. Results for test conditions for bag claim based on area per passenger.

Test Condition for Area	Data Group A	Data Group B	p-value	Significant Difference
Condition 1	Area ≤ 5 sq ft per passenger	Area > 5 sq ft per passenger	–	No data
Condition 2	Area ≤ 10 sq ft per passenger	Area > 10 sq ft per passenger	–	No data
Condition 3	Area ≤ 15 sq ft per passenger	Area > 15 sq ft per passenger	–	No data
Condition 4	Area ≤ 20 sq ft per passenger	Area > 20 sq ft per passenger	.610	No

Table 34. Additional breakdowns of data groups.

Test Condition for Purpose of Trip	Data Group A	Data Group B
Condition 1	Business	Leisure
Condition 2	Domestic	International
Condition 3	Legacy carriers	Low-cost carriers

Table 35. Average perception ratings by function and passenger trip purpose.

Function	Business	Leisure	p-value	Significant Difference
Curbside	1.5	1.8	.236	No
Check-in agent	2.3	2.5	.155	No
Kiosk	2.2	2.1	.290	No
Bag drop	2.3	2.1	.406	No
SSCP	2.0	1.9	.098	No
APM	1.6	1.5	.313	No
Corridor	1.9	1.9	.588	No
Holdroom	1.9	1.9	.750	No
Bag claim	2.2	2.1	.222	No

Table 36. Average perception ratings by function and passenger arrival or destination market.

Function	Domestic	International	p-value	Significant Difference
Curbside	1.7	*	–	No data
Check-in agent	2.4	2.5	.326	No
Kiosk	2.1	2.2	.471	No
Bag drop	2.2	2.2	.982	No
SSCP	1.9	2.2	.001	Yes
APM	1.5	1.5	.778	No
Corridor	1.9	1.7	.371	No
Holdroom	1.8	2.1	.027	Yes
Bag claim	2.1	2.4**	.417	No

*No international passengers at curbside
**Passengers who arrived at up-line international gateways

Table 37. Breakdown of airline type for carriers sampled for this study.

Legacy Carriers	Low-Cost Carriers
American	AirTran
Continental	Allegiant
Delta	JetBlue
Northwest	Southwest
US Airways	
United	

Table 38. Average perception ratings for each function by type of airline.

Function	Legacy Carriers	Low-Cost Carriers	p-value	Significant Difference
Curbside	1.2	1.8	.012	Yes
Check-in agent	2.3	2.5	.142	No
Kiosk	2.1	2.3	.076	No
Bag drop	2.1	2.7	.247	No
Holdroom	1.9	1.8	.013	Yes
Bag claim	2.2	2.4	.037	Yes

Table 39. Qualitative data summary.

Response Category	Positive Comment	Negative Comment	Would Like to See
Cleanliness	17	1	0
Congestion	0	6	0
Dining	17	5	12
Family friendly	1	1	9
Handicapped facilities/procedures	6	2	1
Moving walkways	0	1	6
Noise level	0	7	0
Paid amenities	0	1	5
Parking	2	2	2
Personal Amenity Space/Comfort	16	11	20
Restrooms	6	2	1
Shuttle system	3	4	1
Smoking facilities	3	2	3
Train system	18	3	0
TSA/ICE issues	22	15	3
Airport layout (size/distance/convenience)	11	9	0
Rental car facility	2	0	0
Airline customer service (agent-based)	14	13	0
Airport customer service (information booth)	5	1	1
Information displays (airline/flight info)	2	3	1
Airline customer service (machine-based/kiosks)	8	7	2
Airline logistics (flight delays/baggage handling)	4	20	0
Free amenities (television/outlets/Wi-Fi/clocks)	7	5	18
Wayfinding (signage/information booths)	28	14	12

CHAPTER 4

Conclusions and Recommendations for Further Research

Conclusions

Relationship Between Passenger Perception of LOS and Area

The results of the data collection and analysis did not identify a relationship between passengers' perceptions of LOS and the amount of space that was available to them for any airport function studied. There are two important aspects of this finding:

1. The data did not indicate a turning point for any airport function studied where the average perception becomes unacceptable for passengers based on the amount of available space around them. This may be because there were not many times during our data collection period when passengers felt they had to compromise their personal space due to congestion. Perhaps one reason for this is that the facilities were generally well designed to handle the design demand. Another reason may be that passengers avoid situations where overcrowding may occur and either wait in adjacent or nearby areas or choose to engage in other activities (such as shopping or dining).
2. It is clear that higher levels of area per passenger ***do not*** enhance passenger perception of any functional area. There are many instances where in the same location, with the same area per passenger, some passengers perceived the LOS to be high while others perceived the LOS to be low. This result implies that something other than area per passenger is driving the perception. Additionally, this result indicates that intentionally increasing the size of the functional area in the hope of attaining higher levels of passenger satisfaction will not achieve that result.

Since a turning point for perception due to area afforded each passenger could not be found during our data collection, the study team cannot propose a space-planning guideline based on empirical research findings. In the absence of further research, we suggest continued use of the LOS C space allocations recommended by the IATA *Airport Development Reference Manual* (*1*), with the following caveats:

- All necessary airport terminal processors should be present in the design and sized to produce a balanced flow.
- There should be convenient, adjacent, or nearby places for passengers to wait when congestion in one particular area produces excessive density, since the study observed that passengers self-regulate their comfort by waiting in other areas.
- Passenger demand used to size the space to the LOS C standard should be based on the end of the planning or design horizon. Thus airport owners and business partners should understand that the initial space on opening day will result in a better LOS and that passenger growth over the design life of the facility may result in the facility degrading to LOS C.

The study team's reasoning for proposing this space-planning and design standard is as follows:

- The prevailing practice at North American airports for many years has been to develop facilities to provide at least IATA LOS C. This study indicates that passengers are largely satisfied with the space available to them at the airports studied. Additionally, the prevalent use of the LOS C design criteria appears to be financially acceptable to project sponsors.
- The IATA LOS C space guidelines and the LOS C space guidelines proposed by John Fruin (*2*) are approximately equivalent when accounting for the presence or absence of checked baggage at various airport processors. Dr. Fruin's research on pedestrian queuing behavior was extensive and has served as a sound basis for planning and design for many years.

Relationship Between Passenger Perception of LOS and Time

The data collection and analysis did show a relationship between the amount of waiting/processing time a passenger experiences and his or her perception of LOS. Waiting time appears to have a negative effect for processes where passengers wait in queue for a limited number of processors, such as staffed agent check-in and bag claim. Although the data did not indicate a graduated decline in passengers' perceptions of LOS associated with wait time, we were able to determine TPs for several of these airport functions where the average perception becomes unacceptable. Due to the nature of this data collection (finite data collection resources coupled with facilities/operations that performed reasonably well even during peak travel periods), the study did not delineate TPs for every airport function studied.

For the four areas where the study team did identify turning points in wait-time data (i.e., when passenger perception changed from acceptable to unacceptable), passenger tolerance was surprisingly high relative to typical planning and design criteria. This finding may be the result of inherent bias in the passenger intercept survey technique—fairly tolerant people are the ones willing to participate in surveys. Therefore, relatively longer wait times are required to exceed the limits of their patience.

Differences in Passenger Perceptions of LOS Associated with Air Service Market Differences

Airport planners are frequently asked about potential differences in passengers' expectations regarding LOS that might be associated with the type of air service they are using. Study data were analyzed to identify differences between legacy carrier and low-cost carrier passengers, business and leisure passengers, and international and domestic passengers. Generally, there were few differences identified. The study data indicated no significant difference between perceptions of LOS between business and leisure passengers. There were significantly different and slightly lower perception ratings from international passengers in the SSCP and the holdroom areas. Low-cost carrier passengers had significantly different and slightly lower perceptions of the curbside check-in and baggage claim areas, while they had significantly different and slightly higher perceptions of the holdroom area.

The study team further proposes that no special airport development design considerations related to space or wait time be contemplated, based on an assumption that the LOS perceptions of passengers categorized by their type of air service are inherently different. The data simply do not support such initiatives. Certainly there are objective differences in sizing parameters associated with aircraft type or capacity as well as differences in load factor or processing requirements based on government policy (in the case of domestic versus international passengers) associated with different air service passenger types. The study team attributes this lack of difference in passenger perceptions of LOS to the fact that passengers are likely to use all of these types of air service, and their perception of LOS is inherent rather than a function of the carrier they are using.

Ethnographic Findings Related to Passengers' Perception of LOS

The ethnographic findings of the data collection study are some of the most significant. The results of the ethnographic study support the conclusions of the quantitative data collection. However, the qualitative analysis identified other factors wholly unrelated to time or space that may have a significant impact on passenger perception or even be the key to their dynamic or holistic perception of the entire process. Certainly, many of these factors are controlled by individual airlines or government agencies, and some of these factors could be influenced by the airport during the design process. Many of these factors are not considered explicitly or early in the planning and design process or are left for tenants or concessionaires to achieve as part of their development responsibility. The study data indicate that achieving higher levels of passenger perception of LOS requires that the airport planning and design process have more influence over these factors.

A key finding of the ethnographic data collection is that in order to reduce passengers' stress and thus increase their perceptions of LOS, it is important that they feel they are in control of the success of their journey. For example, the finding that passengers' perceptions of LOS are associated with wait time is an expression of this concern about the success of their journey (and unfortunately, sometimes beyond the control of the airport planner or owner). However, examples of airport planning and design matters that affect the passengers' perception of control include

- Intuitive wayfinding: This includes not only a well-designed and -implemented signage system, but more importantly, design that supports clear passenger sight lines through the successive steps in their journey, from landside to airside and vice versa. Sight lines must be considered early in the design stage if it is a goal to achieve unobstructed views through each successive terminal processor. Providing these clear sight lines may affect facility development cost, so it is important to develop design criteria that weight such intuitively obvious wayfinding heavily.
- Short walk distances or quick travel times: Passengers need to trust that they have enough time to travel from landside

to their outbound gate to catch their flights. Although travel time information may assuage passenger fears, short walk distances are most comforting (as well as less exhausting). Passenger walk distances, or alternatively passenger conveyance systems that reduce travel time, must be an inherent consideration when evaluating airport development alternatives.

- Ubiquitous and reliable flight status information: Information about the current time, the time required to complete each successive processing step, and flight status are all necessary for passengers to feel that the success of their journey is not being threatened. This information must be provided so that it is available wherever a passenger may be stuck waiting in the airport. It is also necessary for the passenger to feel comfortable that he/she has time to use airport concessions to acquire food, beverage, or retail items. Provision of systems that provide reliable flight status information require cooperation with the air carriers or investment in newly developed systems that rely on FAA-based flight status information. Additionally, these systems must be located in many areas of the terminal, along the passengers' routes of travel, or delivered to passengers individually via their mobile communications devices.

Amenities that reflect a respect for passengers' time and needs are another important factor in their high perception of LOS. This is validated by their frustration with long wait times. If they are expected to wait for long periods in a holdroom, they want amenities that allow them to use their time productively. Such items include spaces where they can work, plug in their electronic devices, and connect to the internet easily. Therefore, it is important that these concerns be taken into account when designing and planning holdrooms and other airside spaces.

The data collection highlighted a special subset of passenger needs: a desire for spaces that provide sanctuary. Passengers' well-documented preference for clean facilities is certainly a fundamental aspect of sanctuary. This includes concessions or other terminal spaces (in the holdroom or elsewhere) where passengers can wait comfortably for their flights. For some passengers this may be a quiet place; for others this may be a place where they can watch the news/sporting events or listen to music. In both cases, passengers need reliable flight status information so that they can relax and enjoy the activity they have chosen to pass the time. This is the space-related quality that influences passenger perception of high LOS—the quality of the space and how well it is designed to respond to their needs—rather than the quantity of the space. The airport design should include these areas of sanctuary regardless of whether they are included in concessionaires' facilities.

All of these qualitative factors that influence passenger perception have a definite impact on the planning and design process and add to the cost of facility development. Therefore, given the challenge in raising financial support for airport facility development, it is critically important that the value of these matters to passengers be accurately quantified.

Recommended Further Research

More Data Collection?

The study team did not anticipate that the data collection analysis would fail to identify a relationship between quantity of space and passengers' perception of LOS. However, further review of literature regarding the initial development of the LOS framework indicated that it was based on fairly limited research. When the test of the data collection approach was completed at DFW and the study team learned that the data collection study might not support the traditional view of passenger LOS, the study team took a number of measures to ensure that sample sizes for the quantitative data were adequate to support study conclusions. Therefore, it is not the study teams' recommendation that more quantitative data collection be undertaken.

More Effective Survey Techniques

Should future researchers desire to complete additional study on passenger perception of service based on density, the study team's suggestion is that new survey techniques be identified to capture and quantify passengers' experiences and perceptions. The study team has extensive experience in surveying passengers in ways that are unbiased, minimally intrusive, and objective, and these methods were employed in this research. However, methods that require a harried traveler to interact with another person during his or her journey require a level of tolerance that may not be representative of the traveling public. Therefore, when passengers do choose to participate in data collection efforts, the data come from two sets of passengers: those who are patient and willing to take the time to speak with researchers and those who have been angered by some incident during their journey that motivates them to speak about their experience.

The ethnographic methods appear to be very successful in discerning passenger perceptions. However, the cost of each data point is significantly high, especially compared to the cost of collecting quantitative data.

Since the completion of this research, the study team has been looking for new survey techniques. Techniques that employ mobile technologies such as questionnaires completed and delivered via cell phones and text messaging are promising. Additionally, airports and the TSA are collecting passenger wait-time data at airport processing points through the use of passive Bluetooth technology. The study team recommends that such techniques be explored and tested for their efficacy in quantifying passengers' actual experience as well as their perceptions of it.

The study team does advocate wider use of ethnographic methodology in discerning passenger expectations and perceptions. This approach may be the only way to understand what truly influences passenger perceptions. When less-biased, more cost-effective survey techniques can be identified, it may be worthwhile to attempt more data collection to determine the turning point in the minimum amount of space that is satisfactory to a passenger.

CHAPTER 5

Space Allocation Guidelines

Background

These guidelines are intended to provide updated guidance to aviation stakeholders when evaluating or developing new, expanded, or upgraded North American airport facilities. As detailed in this report, research completed in North American airports in the summer of 2008 did not discern a graduated framework of increased or decreased passenger perception of LOS associated with the density of passenger queues. Moreover, the data collection showed conclusively that passengers ***do not*** perceive higher LOS due to more space being allocated to them as they wait for service at airports.

Therefore, it is not suggested that airport owners or designers who want to produce facilities that will provide higher passenger perception of LOS attempt to achieve this goal by increasing allocation of space per passenger or by making passenger queue spaces larger. Passengers care far more about the quality of the space provided as related to how well that space serves their needs for productivity of waiting time and sanctuary from the stresses of travel.

These guidelines are based on the passenger space allocation guideline for LOS C discussed in IATA's *Airport Development Reference Manual* (*1*). The IATA guidelines are very similar to the space allocation guidelines offered by Transport Canada and by Dr. John Fruin in his book, *Pedestrian Planning and Design* (*2*). This work has been used in practice since the 1970s and has formed the basis for airport terminal development since then. The relatively good passenger-waiting LOS observed in all of the study airports is testimony to the validity of this guidance.

A Few Words of Caution

The ACRP 03-05 study team proposes use of LOS C as an appropriate passenger space allocation goal so long as:

- All necessary airport terminal processors are present in the design and sized to produce a balanced flow.
- There are convenient, adjacent, or nearby places for passengers to wait when congestion in one particular area produces excessive density, since the study observed that passengers self-regulate their comfort by waiting in adjacent or nearby areas.
- Passenger demand used to size the space is based on the end of the planning and design horizon.

It is important that the data used to plan and design passenger spaces be reliable. This means that the data represent current conditions at the airport with respect to air service markets served, airline processing methods and policies in use, and prevailing government regulations. Furthermore, it is important that the data be adjusted as appropriate to represent future conditions at the end of the planning and design horizon so that the terminal layout will be robust through the entire design life. If standard data are used, it is important to understand the operating conditions implicit in the standard in order to ensure that the data are applicable to the airport operation being planned.

Peak Occupancy Demand Forecast

To start, each area studied must have a validated forecast of the peak occupancy of that airport processing area. There are many ways to develop these forecasts, including the application of planning standards to typical demand data usually found in airport master plans. Alternatively, peak occupancy for each area may be derived from an airport programming spreadsheet—either a proprietary tool developed by a qualified aviation consultant or the guidance provided by ACRP. Another option is the output of a detailed computer simulation modeling analysis that provides estimates of peak occupancy for each airport processing area.

Since the peak occupancy forecasts are evaluated by the aviation consultant, it is critical to ensure that certain passenger-behavior–related and air-service–related factors have been accurately applied, including

1. Airport arrival earliness distributions, reflecting the percent of passengers who check in within a distribution of minutes before a departing flight. The earliness distribution often varies based on time of flight departure and type of departure (domestic versus international).
2. First point of airport contact for check-in, the first place that passengers contact air carrier personnel to obtain travel documents or to check bags. Passengers may not need to contact any airline personnel until they reach the gate because they obtained a boarding pass via web check-in or a remote baggage check-in location or they used a personal wireless device to display their boarding documents (and they have no baggage to check). But passengers may contact the airline at curbside to check their baggage and obtain boarding passes, at a self-service machine (and associated bag drop location) to obtain travel documents and possibly check baggage, or at a staffed check-in counter to obtain assistance from an airline ticket agent.
3. Aircraft seat factor (sometimes termed "load factor") to account for the number of seats occupied as opposed to the total number of seats available.
4. Percentage of passengers originating their travel or terminating their travel at the airport [origin and destination (O&D) factor]. These are the only outbound passengers that will use the curbside roadway, the check-in lobby, and the security screening checkpoint, and the only inbound passengers that will use the domestic baggage claim. Stated another way, these are the only passengers who will access the non-secure side of the airport terminal. The other passengers—connecting passengers—will only use the areas on the secure side of the airport terminal.
5. Applicable airport processing times so that as passengers queue for service, the product of the service time and the total number of processors determines the processing throughput of the area. The number of passengers who arrive in excess of the throughput of the area will determine the peak occupancy of the queue area.
6. Travel party size, representing the number of passengers that remain together while everyone in their group is processed.
7. Number of checked bags per passenger or travel party, representing the additional demand for space created by the checked bags in terminal areas where the passengers are in possession of their checked baggage; consideration should also be given to convenient ways to handle oversized baggage, the percentage of passengers that use baggage carts, and so forth.
8. Mode of transportation to/from the airport, which in some cases will determine which entrance, exit, or route through the terminal that the passengers or their greeters may use. This information is useful in determining maximum peak occupancy of certain meeting areas.
9. Number of visitors who accompany the passenger while in the terminal. The planner/designer needs to accommodate this additional occupancy as appropriate.

Passenger Space Allocations

Table 40 summarizes the space allocation guidelines and other important considerations for each terminal processing area. In applying these guidelines, remember that the space allocation applies only to the passenger queuing areas. Additional space must be allocated for circulation to/from the area, and space must be set aside for special processing that may occur within the area.

Table 40. Passenger space allocation guidelines for processing areas.

IATA Name of Area	Application	Space Allocation	Important Considerations
Check-in area	Curbside check-in, check-in hall, FIS recheck	Varies by bag cart use and bags per passenger: 12.9 sq ft per pax – few carts, few bags 14.0 sq ft per pax – few carts, 1-2 bags per pax 18.3 sq ft per pax – high % of carts 21.5 sq ft per pax high % of carts, 2+ bags per pax	Do passengers' visitors wait with them in queue? If a uni-queue is used to organize the passenger waiting area, does the width of the queue require that the overall standard be increased to provide adequate length of space to accommodate the travel party, their baggage, and baggage cart? Remember, this standard is used to generate passenger waiting area only. Additional area needs to be allocated for circulation to/from the queue exit to the face of the check-in counter.

(continued on next page)

IATA Name of Area	Application	Space Allocation	Important Considerations
Wait/ circulate	Meeter/greeter halls, corridors	Varies by type of area: 16.1 sq ft = airside, no carts 19.4 sq ft = public after check-in, few carts 24.8 sq ft = departure before check-in, carts	Be sure to account for visitor earliness; it may be helpful to consult Fruin's corridor or walkway LOS guidelines as well. Use of large mechanized carts or moving sidewalks to transport passengers will require special planning considerations.
Holdroom	Gate lounges or any seated waiting area	65% of capacity or less is LOS C Capacity measured by: 18.3 sq ft per seated pax 12.9 sq ft per standing pax	This standard needs to be reviewed relative to the size of seats, the width of aisles between the seats, and the mix of passengers seated and standing in the holdroom. Additionally, area must be provided over and above the seating/waiting area for the gate agent counter, any boarding pass reader, and any specially organized area for the boarding bridge queue or the deplaning aisle. It is also important to consider any airline-specific strategic space allocation to passenger amenities.
Baggage claim (exclusive of device)	Domestic or international baggage claims	18.3 sq ft per pax based on 40% cart use. For some domestic claims, it may be appropriate to modify this to 14.0 sq ft to represent minimal cart use.	The space allocation must also take into consideration the ability of passengers to reach the claim area in time to pick up their baggage. That means that the maximum depth of queuing around the device must not exceed 11.5 ft (per IATA); consideration must also be given to the number of baggage carts used by passengers. This standard assumes that 40% of passengers use a baggage cart. The assumption may need to be adjusted to represent local conditions.
Government inspection	FIS primary inspection, outbound security inspection	10.8 sq ft	This standard is good for areas within the government inspection facility where passengers do not have their checked baggage with them. Customs secondary inspection areas or exit control lanes should use a larger space allocation (e.g., 17.2 sq ft).

Source: IATA *Airport Development Reference Manual* (*1*) and *Pedestrian Planning and Design,* Fruin (*2*)
Note: pax = passenger

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APPENDIX A

Airport Snapshots
Individual Airport Information Data Collection Photos with Square Footage

DFW—Dallas–Fort Worth International Airport

Dallas–Fort Worth, Texas

Quick Facts and Stats

First opened in 1974, DFW is classified as a large airport by the FAA, which is easy to see by both its footprint and flight operations. DFW covers more than 29.8 square miles, has seven runways, and is the only airport in the world with three control towers. DFW offers nearly 1,900 flights per day.

Located halfway between the cities of Dallas and Fort Worth, DFW provides nonstop service to 135 domestic and 38 international destinations worldwide from 20 different airlines positioned at 155 gates. The airport serves American Airlines as their largest hub. In 2007, DFW served 59,786,476 passengers through 685,491 total operations and moved 797,511 U.S. tons of cargo.

Airport Services

With its size, DFW is able to offer many services for its passengers. These services include an on-site hotel, children's play areas, Wi-Fi (T-Mobile, fee based, throughout airport), barber shop/salon, chapel, travelers aid and local information stations, security checkpoint mailing stations, credit union, business centers, ATMs, and a variety of restaurants and shops. To support the traveling military, DFW provides a large USO center in one terminal and a smaller center in another terminal. There are fine art exhibits throughout the airport as well.

Governance

DFW has a board of directors composed of 12 members, 11 of whom are appointed by the city councils of the airport's owner cities. That is, seven represent the City of Dallas and four represent the City of Fort Worth, in accordance with each city's ownership interest in the airport. The DFW Airport Board is a semi-autonomous body charged with governing DFW. The board may enter into contracts without the approval of its owner cities' city councils, but their approval is required for its annual budget, bond sales, and similar measures.

DFW is designed with expansion in mind, and can theoretically accommodate up to 13 terminals totaling 260 gates.

The terminals at DFW are semicircular (except for the newest terminal, Terminal D, which is a "square U" shape) and built around the airport's central north–south arterial road, Spur 97, also known as "International Parkway." Until the late 1990s, they were designated by a number (2 being northernmost, 4 being southernmost) and a letter suffix ("E" for East, "W" for West). This system was later scrapped, and the terminals are now lettered from A to E. Terminals A, C, and E (from north to south) are on the east side of the airport, while Terminals B and D (from north to south) are on the west side.

DFW's terminals are designed to minimize the distance between a passenger's car and airplane as well as reduce traffic around terminals. A consequence of this layout is that connecting passengers had to walk extremely long distances between gates (in order to walk from one end of the semicircular concourse to the other, one must walk the entire length; there are no shortcuts between the ends). The original people-mover train (Airtrans APM) that opened with the airport was notoriously slow [17 mph (27 km/h)], uni-directional (running only in a counterclockwise direction), and was located outside the secured area (thus requiring travelers to go through the security process again). It was replaced by SkyLink in April 2005 after serving approximately 250 million passengers. Skylink serves all five terminals at a considerably higher speed, is bi-directional, and is located inside the secured area.

DFW – Bag claim 4: 1,560 sq ft

DFW– Holdroom/gate 15: 1,600 sq ft

DFW – Kiosk (American Airlines)

The four oldest airport terminals, Terminals A, B, C, and E, are being renovated starting in May 2011. The estimated cost is $3 billion, and work is expected to be complete by 2017.

DFW and local Metroplex officials are also actively seeking additional passenger service.

AUS—Austin-Bergstrom International Airport

Austin, Texas

Quick Facts and Stats

Austin's global aspirations for expanding air services were taking place just as the U.S. Air Force was making plans to close Bergstrom Air Force Base, an Austin fixture since World War II. While some saw a large, empty airfield, others saw an opportunity. This vision led to the first U.S. conversion of an Air Force base to commercial service airport since the end of the Cold War. The reconstructed airbase was opened on May 23, 1999, as Austin-Bergstrom International Airport.

Located in Central Texas, Austin is Texas's fourth-largest city and its capital. AUS is a medium hub airport with two parallel runways. Its 600,000-sq-ft passenger terminal with 25 gates supports 12 airlines. The terminal was constructed at a cost of $115 million, and the design celebrates two central themes key to Austin: the community's love of nature and an expression of the city's status as an educational and technological center. As Austin grows and the need arises, the terminal's design allows for easy expansion—up to 55 gates if necessary. Additionally, AUS has four cargo terminals and emergency response services to meet Fire Category D airport standards.

Airport Services

Austin is known as the "Live Music Capital of the World," so it is fitting that the crown jewel of the Austin-Bergstrom International Airport is its "*Music in the Air*" program. Live musical performances are held daily in the center of the terminal building on the concourse level. Located on the secure side of the concourse, the stage is accessible to ticketed passengers only, but the music can be heard in the non-secured areas directly behind the stage. Additionally, AUS has an arts program that celebrates the region, Wi-Fi (Wayport, fee based, throughout airport), massage stations, dog walk area, travelers aid and local information stations, credit union, business center, ATMs, and a variety of restaurants and shops.

Governance

Managed by the City of Austin Aviation Department, oversight for Austin's city-owned airport operations and mainte-

AUS – Ticketing/ Southwest Airlines: 525 sq ft

AUS – Corridor: 2,700 sq ft

AUS – Holdroom/Gate 16/18: 4,812 sq ft

nance began in 1958. The department has operated as a self-supporting entity since 1972. It does not receive any general fund subsidy and has paid for all general obligation debt issued from airport-generated funds. Their business plan is guided by the Aviation Department mission to provide quality airport facilities and services by focusing on customers' needs and employees' work environment, continually improving operations and preparing for the future.

OAK—Oakland International Airport

Oakland, California

Quick Facts and Stats

In 1927, Colonel Charles A. Lindbergh presided over the dedication of the Oakland Municipal Airport. In May 1937, Amelia Earhart and Fred Noonan, her navigator, took off from Oakland for what was meant to be an around-the-world trip. Since that time many changes have taken place at the airport, including a name change and a $1.4 billion expansion project.

Located near the San Francisco Bay Area, OAK is a medium hub airport with four runways. The airport has two terminals with 29 gates supporting 258 daily departures with 188 daily nonstop flights to 33 destinations. New Terminal 2 facilities will include a 27,000-sq-ft baggage-claim area and a 54,000-sq-ft, seven-gate concourse.

Airport Services

OAK boasts the Metropolitan Golf Links with 18 bentgrass greens. In addition to the golf course, OAK has an aerospace museum and a public arts program. Passengers can find food and beverage pre- and post-security, free Wi-Fi (throughout Terminals 1 and 2), local information stations, a business center, ATMs, valet parking, and a variety of restaurants and shops.

Governance

The Port of Oakland oversees the Oakland seaport, Oakland International Airport, and 20 miles of waterfront. The Oakland seaport is the third busiest container port on the U.S. West Coast. The Port's real estate includes commercial developments such as Jack London Square as well as hundreds of acres of public parks and conservation areas. The Port of Oakland was established in 1927 and is an independent department of the City of Oakland.

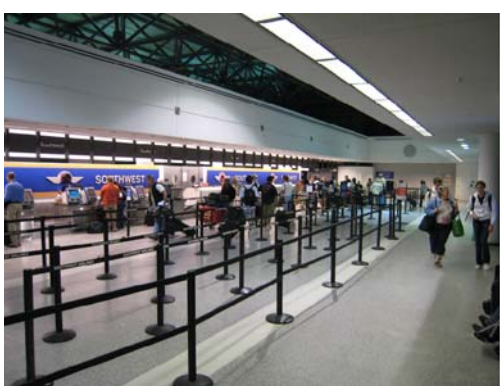
ATL—Hartsfield-Jackson International Airport

Atlanta, Georgia

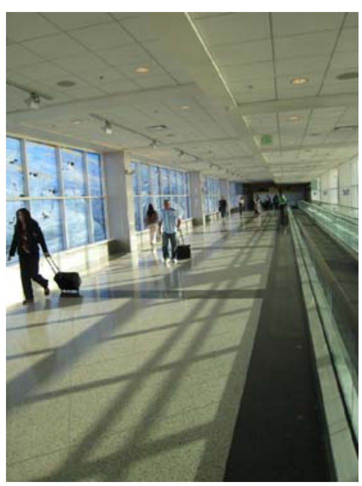
Quick Facts and Stats

A long way from its 1925 beginnings as an abandoned auto racetrack, Hartsfield-Jackson Atlanta International Airport has a total airport area of 4,700 acres. Now the largest passenger terminal complex in the world, covering 2.5 million square feet, the airport was designed to accommodate up to 55 million passengers a year—in 1980. By 1998, ATL accommodated 73.5 million travelers. Currently, ATL concourses include 146 domestic and 34 international gates, and ATL is known as "the world's busiest airport," serving more than 89 million passengers annually with 34 passenger and 16 cargo airlines. ATL serves as a hub for both Delta Air Lines and AirTran. ATL has five runways and emergency response services to meet aircraft rescue and firefighting (ARFF) Index E airport standards.

A frequent recipient of awards for excellence for operations, architectural engineering, and construction, ATL is undergoing more than $6 billion in capital improvements. Upgrades and new infrastructure will include an energy-efficient car



OAK – Ticketing/Southwest Airlines:
3,500 sq ft



OAK – Corridor:
3,690 sq ft

OAK – SSCP:
5,900 sq ft

ATL – Holdroom/Gate30:
1,920 sq ft

ATL – Ticketing/Delta:
385 sq ft

ATL – Holdroom/Gate33:
1,240 sq ft

rental facility, a 12-gate international terminal, and aesthetic and functional enhancements to its concourses, people movers, and parking services.

Airport Services

ATL has several innovative offerings for its passengers, such a TRAK-A-LINE and TRAK-A-FLIGHT. Registered passengers can receive updated flight and security wait time information via e-mail, PDA, or mobile devices.

There are over 225 concession outlets throughout ATL, including 89 food/beverage outlets, 85 retail/convenience outlets, and 55 fully staffed service outlets covering nearly 209,000 sq ft.

Other services at ATL include The AeroClinic (a full-service airport-based medical clinic), children's play areas, Wi-Fi (fee based, throughout airport), interfaith chapel, travelers' aid and local information stations, U.S. Post Office drop box and store, full-service banking, business centers, and ATMs. To support the traveling military, ATL provides a USO center in its center atrium. There are both permanent and rotating fine art exhibits throughout the airport as well. Future construction projects are expected to add nearly 75 new outlets, including spas, wine bars, and high-end retailers.

Governance

Named for two former Atlanta mayors and strong airport advocates, William B. Hartsfield and Maynard H. Jackson, Hartsfield-Jackson Atlanta International Airport is owned and managed by the City of Atlanta/Department of Aviation.

LAS—McCarran International Airport

Las Vegas, Nevada

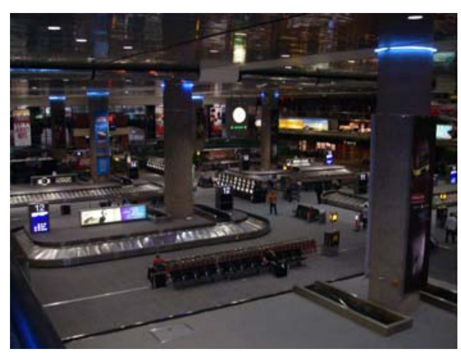
Quick Facts and Stats

Las Vegas' convention and entertainment industries, together with unparalleled outdoor recreation, have stimulated phenomenal growth in Southern Nevada. Today, nearly half of all Las Vegas visitors arrive by air via McCarran International Airport, making it one of the busiest 15 airports in the world. LAS is a valuable community asset that links Southern Nevada to the national air transportation system and brings the world to Las Vegas. Income derived from aviation activity generates significant economic benefits estimated at $25 billion a year.

Named after the former Nevada Senator Pat McCarran, the airport is located 5 miles south of the central business district.

LAS – Ticketing/Delta:
576 sq ft

LAS – Ticketing/U.S.:
576 sq ft

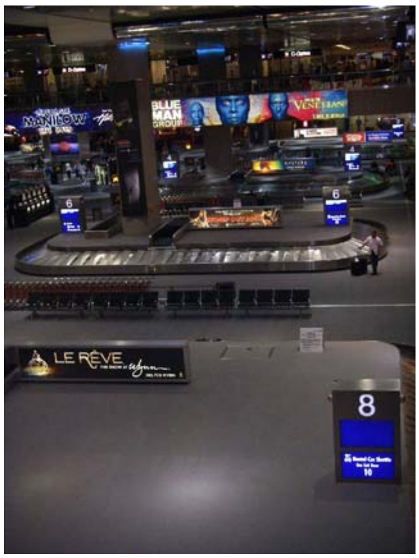


LAS – Bag Claim BC10:
1,344 sq ft

LAS – Bag Claim BC11:
1,072 sq ft

LAS – Bag Claim BC14:
1,072 sq ft

LAS – Bag Claim BC2:
1,072 sq ft



LAS – Bag Claim BC6:
1,072 sq ft

LAS – Bag Claim BC7:
1,072 sq ft

Currently, LAS has two terminals with 95 domestic and four international gates. This large hub airport served more than 23 million passengers in 2007 with its four runways.

Airport Services

Atypical of North American airports, LAS allows its passengers to gamble both upon arrival and departure, with over 1,300 video gaming slot machines available pre- and post-security.

For fast and easy check-in, the Clark County Department of Aviation provides “Speed ✓” and “Speed ✓ Advance.” “Speed ✓” is a common-use self-service (CUSS) kiosk that allows passengers on any participating airline to check in and print their own boarding passes without going to the ticketing counter. “Speed ✓ Advance” allows passengers to check baggage, several hours prior to departure, at any one of four Las Vegas locations, including the consolidated rental car facility. Additionally, LAS was the first airport to provide Wi-Fi as a free service for the entire facility.

Other services at LAS include kids’ play areas, travelers aid and local information stations, mail drop boxes, full-service banking, and ATMs. LAS has both a permanent art gallery and an aviation museum in the airport as well. There are over 80 concession outlets throughout LAS, including nearly 30 restaurants, lounges, and snack bars and 50 retail shops.

Governance

McCarran and the four general aviation facilities in the Clark County Airport System are owned by Clark County, Nevada, and operated under the policy direction of the Board of County Commissioners, the authority of the County Manager, and the management of the Director and Deputy Director of Aviation.

SDF—Louisville International Airport

Louisville, Kentucky

Quick Facts and Stats

Named for Dr. Elisha David Standiford—a businessman and legislator who played an important role in Louisville transportation history and owned part of the land on which the airport was built—Standiford Field opened for passenger business on November 15, 1947. Within 60 years of opening, the airport has accommodated more than 3.8 million passengers. This was made possible due to a $26 million terminal renovation project completed in 2005.

Located 10 min from downtown Louisville, Kentucky, SDF is a low-fare, medium-hub airport with three runways. The airport has two terminals (one passenger and one cargo) with 23 gates drawing travelers within a 200-mile radius of the city. The airport currently has nonstop service to 26 destinations and convenient connections to cities worldwide. Additionally, SDF has emergency response services to meet ARFF Index C airport standards.

In addition to commercial passenger and general aviation activities, SDF is home to the Kentucky Air National Guard and UPS. The airport ranks third in North America—and ninth in the world—in the total amount of cargo handled as home of UPS's international air-sorting hub. On September 27, 2002, Worldport, a $1.1 billion package-sorting center, was opened by UPS at SDF. Four years later, UPS announced a $1 billion expansion that would increase sorting capacity over the following 5 years and create more than 5,000 additional jobs.

Airport Services

To support military functions at Fort Knox, Kentucky, the airport has a military reception area to assist military personnel and their dependents. The airport's public arts program, founded by the Standiford Art Foundation (among the first foundations of its kind), solicits contributions for the placement of art and original commissions throughout the airport. Passengers can find food and beverages pre-and post-security, Wi-Fi (fee based through Boingo, throughout airport), local information stations, a business center, full-service banking, ATMs, valet parking, and a variety of restaurants and shops.

Governance

The Louisville Regional Airport Authority (LRAA) is an independent public agency that owns and is responsible for the daily operations and the long-term planning of SDF. The forerunner of LRAA was established in 1928 by the Commonwealth of Kentucky's General Assembly and has evolved into the current structure.

Much like a private corporation, the authority is self-funded and derives operating revenue from a variety of user fees. The authority does not receive local or state funding for routine operations.

IAD—Washington Dulles International Airport

Sterling, Virginia (Washington, D.C., Metropolitan Area)

Quick Facts and Stats

Serving the greater Washington, D.C., metropolitan area, IAD is located on 12,000 acres of land 26 miles from downtown Washington, D.C. The airport is named after John Foster Dulles, United States Secretary of State under Dwight D. Eisenhower.

The main terminal, designed by architect Eero Saarinen, opened in 1962. Flights operate from midfield concourses A, B, C and D and Z-gates connected to the main terminal. The airport is currently in the midst of a major construction program, which includes the expansion of Concourse B, a new runway, and an automated people mover system called AeroTrain.

Dulles is a large hub airport, providing nonstop service to 88 domestic and 42 international destinations worldwide from 143 gates. It serves as a United Airlines hub operation. In 2007, IAD served 24.7 million passengers.

Airport Services

Scheduled bus service is provided from IAD to the Smithsonian's Steven F. Udvar-Hazy Center. Between this museum and the one on the National Mall, the largest collection of aviation and space artifacts in the world is showcased.

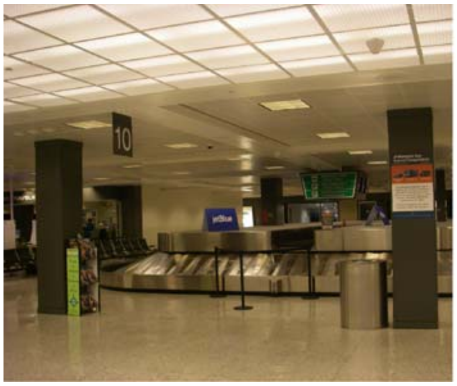
Mobile lounges and plane mates offer a unique service transporting passengers between the terminal and concourses to planes parked a half mile away. The mobile lounge, designed by the Chrysler Corporation, can carry 102 passengers directly from the terminal to the aircraft on the ramp. The plane mates are similar to mobile lounges, designed so passengers can go directly to their aircraft without walking on the airfield. Dulles has 19 mobile lounges and 30 plane mates to support its operation.

Occupying more than 50,000 sq ft, the array of shopping and dining opportunities offered at Dulles includes nearly 100 privately owned and operated food and retail shops located throughout the airport's concourse buildings. A USO center in the baggage area supports the traveling military.

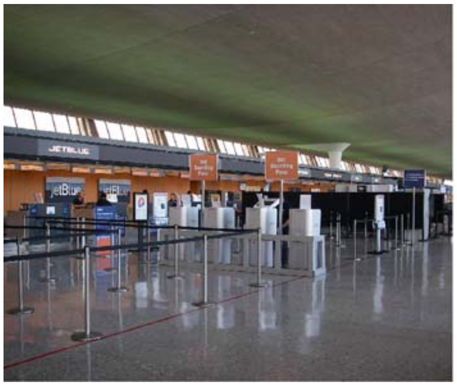
Governance

The Metropolitan Washington Airports Authority is an independent body governed by a 13-member Board of Directors with five members appointed by the Governor of Virginia, three by the Mayor of the District of Columbia, two by the Governor of Maryland, and three by the President of the United States. It has been approved by the U.S. Congress to operate and maintain Ronald Reagan Washington National Airport and Washington Dulles International Airport. The authority is a public body, corporate and politic, and is independent of all other bodies.

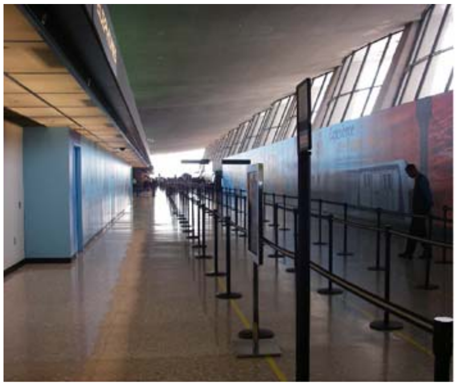
The Airports Authority is not taxpayer-funded but is self-supporting, using aircraft landing fees, rents, and revenues from concessions to fund operating expenses.



IAD – Bag Claim/JetBlue:
1,980 sq ft



IAD – Ticketing/JetBlue:
765 sq ft



IAD – SSCP:
14,400 sq ft

IAD – Corridor D:
4,560 sq ft

APPENDIX B

Remaining Detailed Results

Figures B1 through B8 show the graphical spread of the data collected for all airports for wait times, both in terms of the raw data and averages of 5 min time periods (e.g., 0–5 min, >5–10 min) The data show the relationship between perception score and the time spent in queue or process for a given functional area. For the graphs that show averages, the size of the bubble shows the relative number of data points that make up the average for that period compared to the other periods.

Figure B1 shows the spread of perception data, and Figure B2 shows the distribution of average perception ratings for the holdroom area collected at all airports compared to waiting time. Each X represents at least one data point.

Table B1 shows the results for the test conditions for this functional area based on waiting time. Statistical analysis fails to show a significant difference between time spent in the holdroom and average perception rating for four of the five test conditions (2 through 5) for waiting time. This indicates no definable relationship between time spent waiting and average perception rating for this function. Additionally, for all time periods, the average perception rating remains better than acceptable (less than 3.0). No TP is indicated for these data.

Figure B3 shows the spread of perception data, and Figure B4 shows the distribution of average perception ratings for the curbside process collected at all airports compared to waiting time. Each X represents at least one data point.

Table B2 shows the results for the test conditions for this functional area based on waiting time. Statistical analysis fails to show a significant difference between time spent in the corridor and average perception rating for the first two test conditions (1 and 2) for waiting time. This indicates no definable relationship between time spent waiting and average perception rating for this function. Additionally, for all time periods, the average perception rating remains better than acceptable (less than 3.0). No TP is indicated for these data. Note that there are no data past 11 min and that a relationship could exist past this point if the data could be collected.

Figure B5 shows the spread of perception data, and Figure B6 shows the distribution of average perception ratings for the corridor area collected at all airports compared to waiting time. Each X represents at least one data point.

Table B3 shows the results for the test conditions for this functional area based on waiting time. Statistical analysis fails to show a significant difference between time spent in the holdroom and average perception rating for two of the five test conditions (2 and 3) for waiting time. This indicates that there is no definable relationship between time spent waiting and average perception rating for this function. Additionally, for all time periods, the average perception rating remains better than acceptable (less than 3.0). No TP is indicated for these data.

Figure B7 shows the spread of perception data, and Figure B8 shows the distribution of average perception ratings for the bag drop process collected at all airports compared to waiting time. Each X represents at least one data point.

Table B4 shows the results for the test conditions for this functional area based on waiting time. Statistical analysis fails to show a significant difference between time spent in the bag drop area and average perception rating for three of the five test conditions (1 through 3) for waiting time. This is primarily due to the low sample sizes in each bucket forcing the true estimates of the sample means to overlap considerably. Furthermore, the lack of data after 15 min (as shown in Figure B3) prevents us from making a more definitive conclusion regarding that portion of the graph.

Figures B9 through B20 show the graphical spread of the data collected for all airports for area per passenger both in terms of the raw data and averages of 5 sq ft per passenger area bucket (e.g., 0–5 sq ft per passenger, >5–10 sq ft per passenger). The data show the relationship between perception score and the amount of area available for each passenger for a given functional area. For the graphs that show averages, the size of the bubble shows the relative number of data points that make up the average for that bucket compared to the

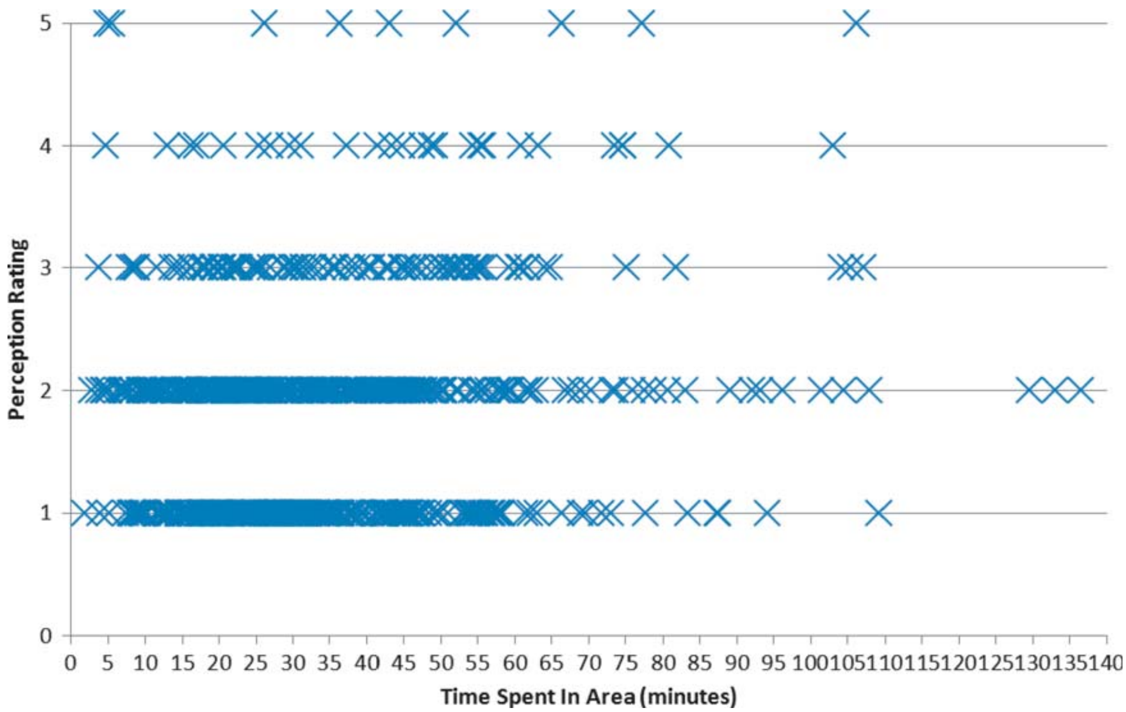


Figure B1. Perception ratings for holdroom by time spent in area.

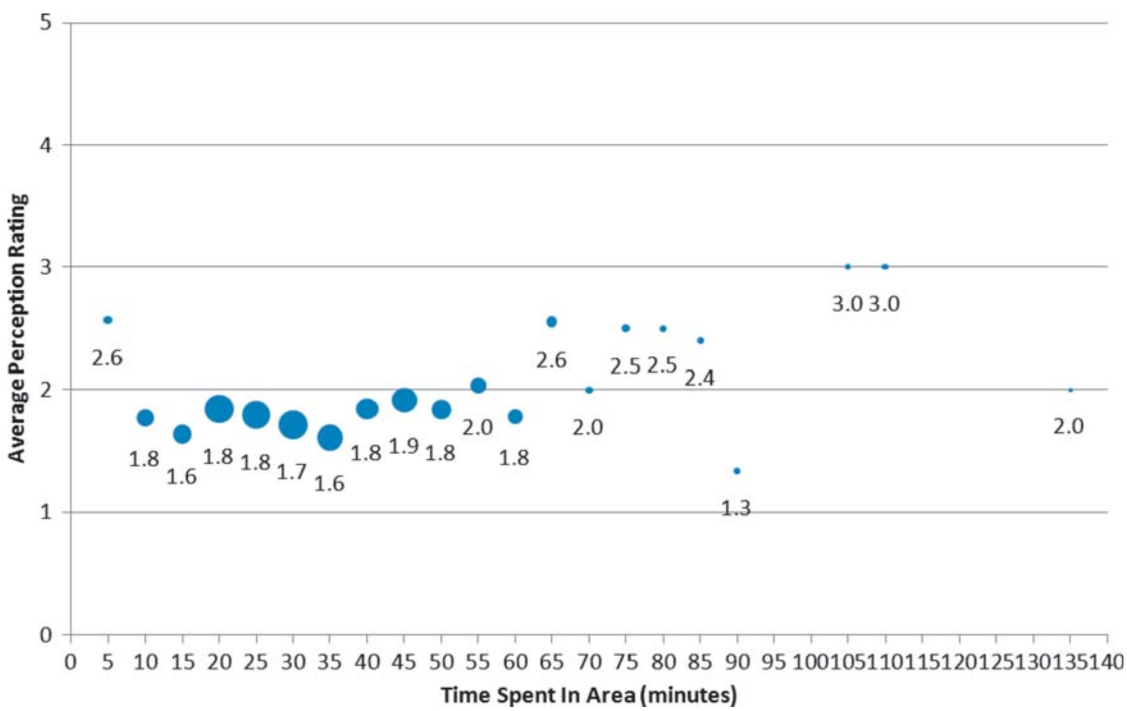


Figure B2. Average perception ratings for holdroom by time spent in area.

Table B1. Results for test conditions for holdroom based on time spent in area.

Test Condition for Wait Time	Data Group A	Data Group B	p-value	Significant Difference
Condition 1	Wait time ≤ 5 min	Wait time > 5 min	.032	Yes
Condition 2	Wait time ≤ 10 min	Wait time > 10 min	.564	No
Condition 3	Wait time ≤ 15 min	Wait time > 15 min	.674	No
Condition 4	Wait time ≤ 20 min	Wait time > 20 min	.721	No
Condition 5	Wait time ≤ 30 min	Wait time > 30 min	.102	No

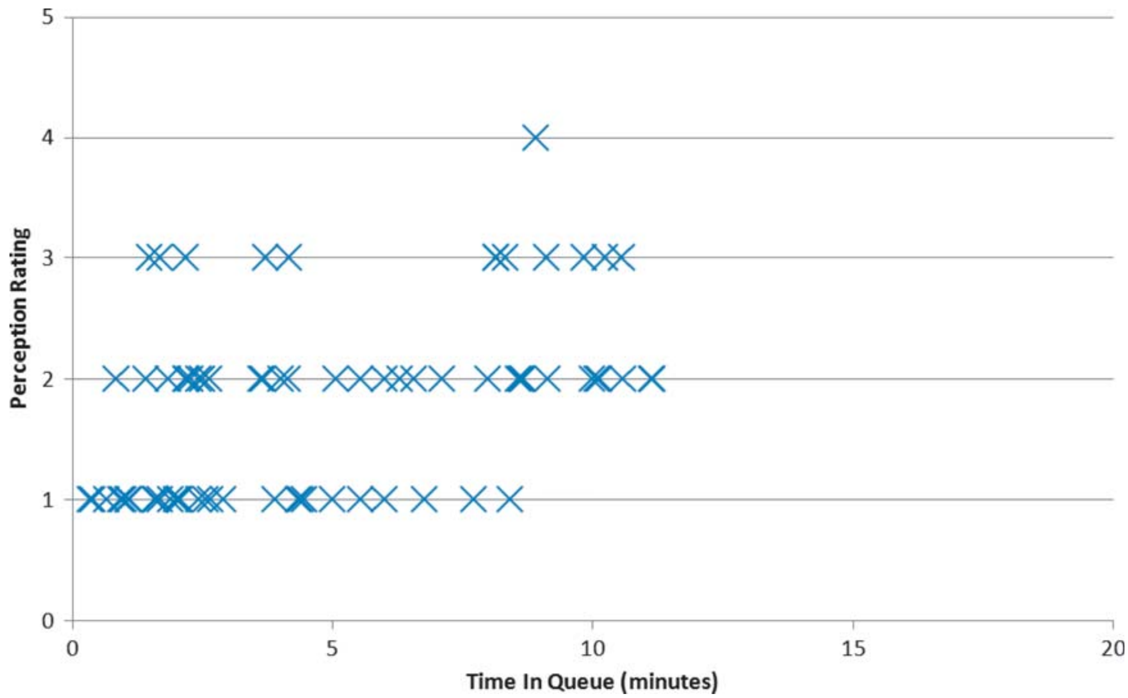


Figure B3. Perception ratings for curbside process by time spent in queue.

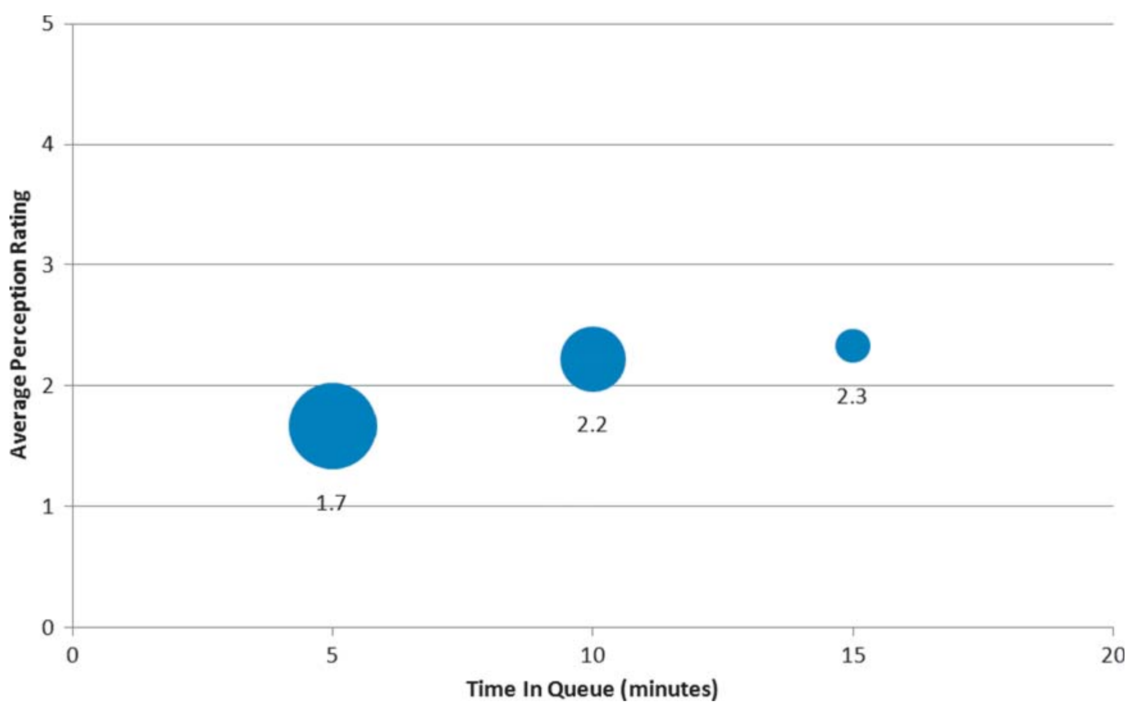


Figure B4. Average perception ratings for curbside process by time spent in queue.

Table B2. Results for test conditions for curbside based on time spent in queue.

Test Condition for Wait Time	Data Group A	Data Group B	p-value	Significant Difference
Condition 1	Wait time ≤ 5 min	Wait time > 5 min	.053	No
Condition 2	Wait time ≤ 10 min	Wait time > 10 min	.322	No
Condition 3	Wait time ≤ 15 min	Wait time > 15 min	–	No data
Condition 4	Wait time ≤ 20 min	Wait time > 20 min	–	No data
Condition 5	Wait time ≤ 30 min	Wait time > 30 min	–	No data

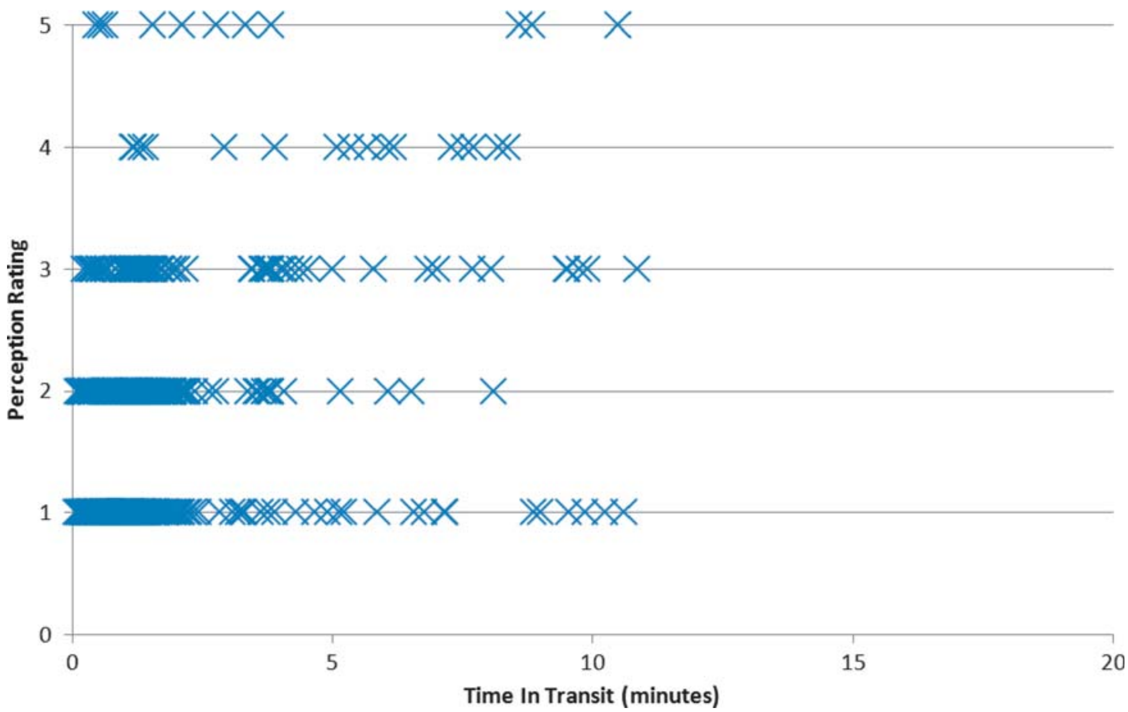


Figure B5. Perception ratings for corridor process by time spent in transit.

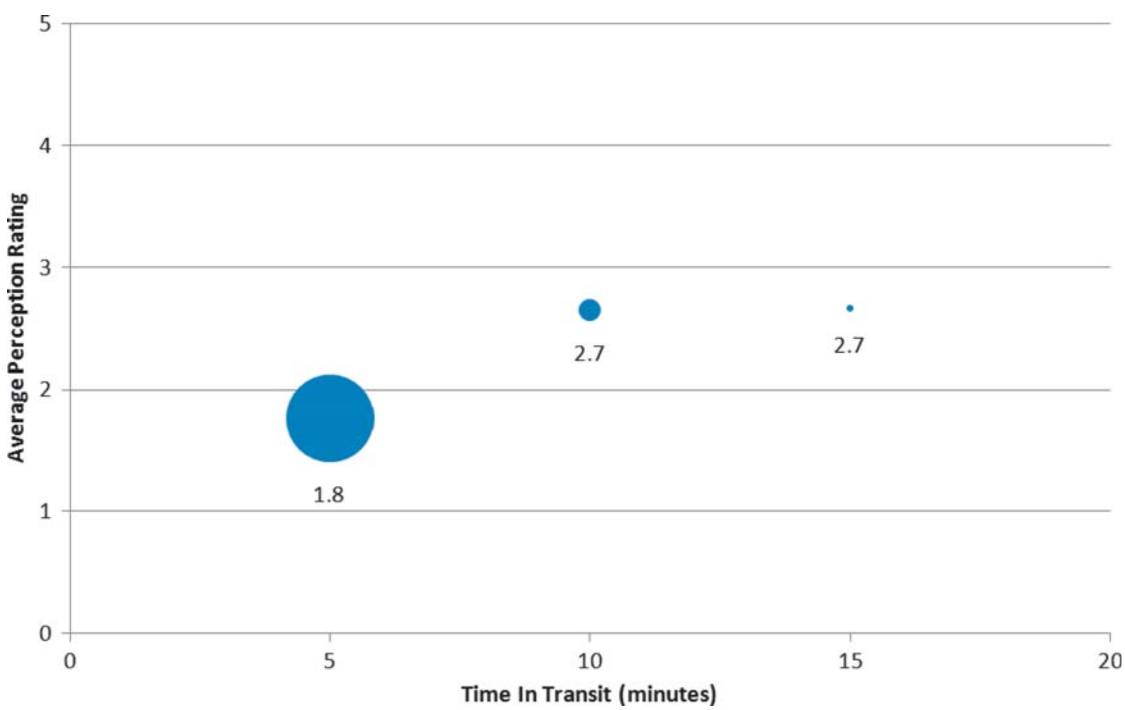


Figure B6. Average perception ratings for corridor process by time spent in transit.

Table B3. Results for test conditions for corridor based on time spent in transit.

Test Condition for Wait Time	Data Group A	Data Group B	p-value	Significant Difference
Condition 1	Wait time ≤ 5 min	Wait time > 5 min	0.00	Yes
Condition 2	Wait time ≤ 10 min	Wait time > 10 min	.107	No
Condition 3	Wait time ≤ 15 min	Wait time > 15 min	.409	No
Condition 4	Wait time ≤ 20 min	Wait time > 20 min	–	No data
Condition 5	Wait time ≤ 30 min	Wait time > 30 min	–	No data

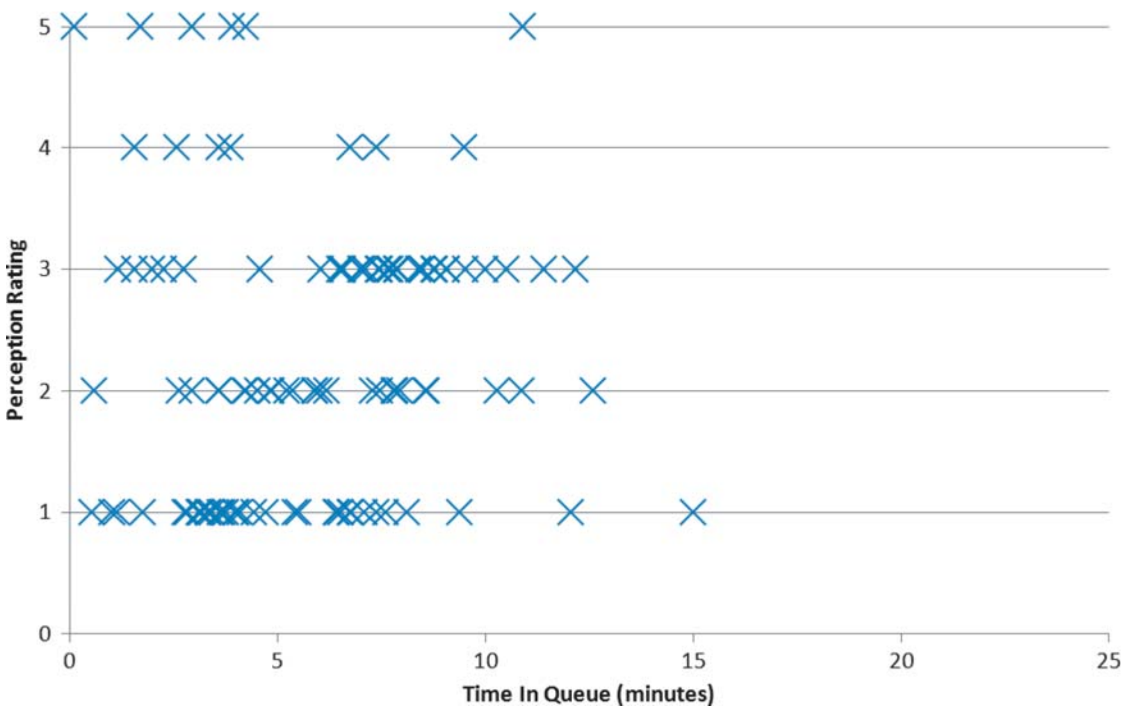


Figure B7. Perception ratings for bag drop process by time spent in queue.

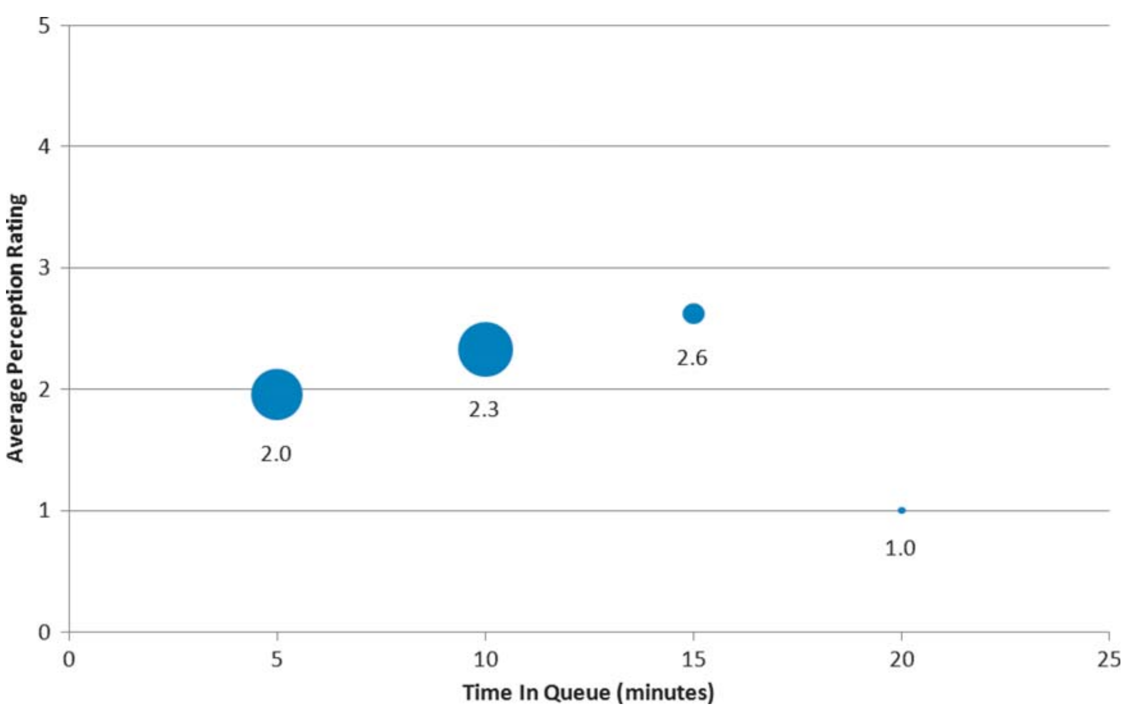


Figure B8. Average perception ratings for bag drop process by time spent in queue.

Table B4. Results for test conditions for bag drop based on waiting time.

Test Condition for Wait Time	Data Group A	Data Group B	p-value	Significant Difference
Condition 1	Wait time ≤ 5 min	Wait time > 5 min	.137	No
Condition 2	Wait time ≤ 10 min	Wait time > 10 min	.410	No
Condition 3	Wait time ≤ 15 min	Wait time > 15 min	.247	No
Condition 4	Wait time ≤ 20 min	Wait time > 20 min	–	No data
Condition 5	Wait time ≤ 30 min	Wait time > 30 min	–	No data

other buckets. Except in a few cases described herein, there does not appear to be a significant correlation between area per passenger and average perception.

Figure B9 shows the spread of perception data, and Figure B10 shows the distribution of average perception ratings for the agent check-in process collected at all airports compared to average passenger area. Each X represents at least one data point.

Table B5 shows the results for the test conditions for this functional area based on area per passenger. Statistical analysis fails to show a significant difference between area per passenger and average perception rating for four test conditions (1 through 4) since there was no applicable data. No TP is indicated for these data.

Figure B11 shows the spread of perception data, and Figure B12 shows the distribution of average perception ratings for the SSCP process collected at all airports compared to average passenger area. Each X represents at least one data point.

Table B6 shows the results for the test conditions for this functional area based on area per passenger. Statistical analysis fails to show a significant difference between area per passenger and average perception rating for two of the four test conditions (1 and 2), but the results show a significant difference for the test conditions 3 and 4. However, for all buckets, the average perception rating remains better than acceptable (less than 3.0) so no TP is indicated for these data.

Figure B13 shows the spread of perception data, and Figure B14 shows the distribution of average perception ratings for the kiosk process collected at all airports compared to average passenger area. Each X represents at least one data point.

Table B7 shows the results for the test conditions for this functional area based on area per passenger. Statistical analysis

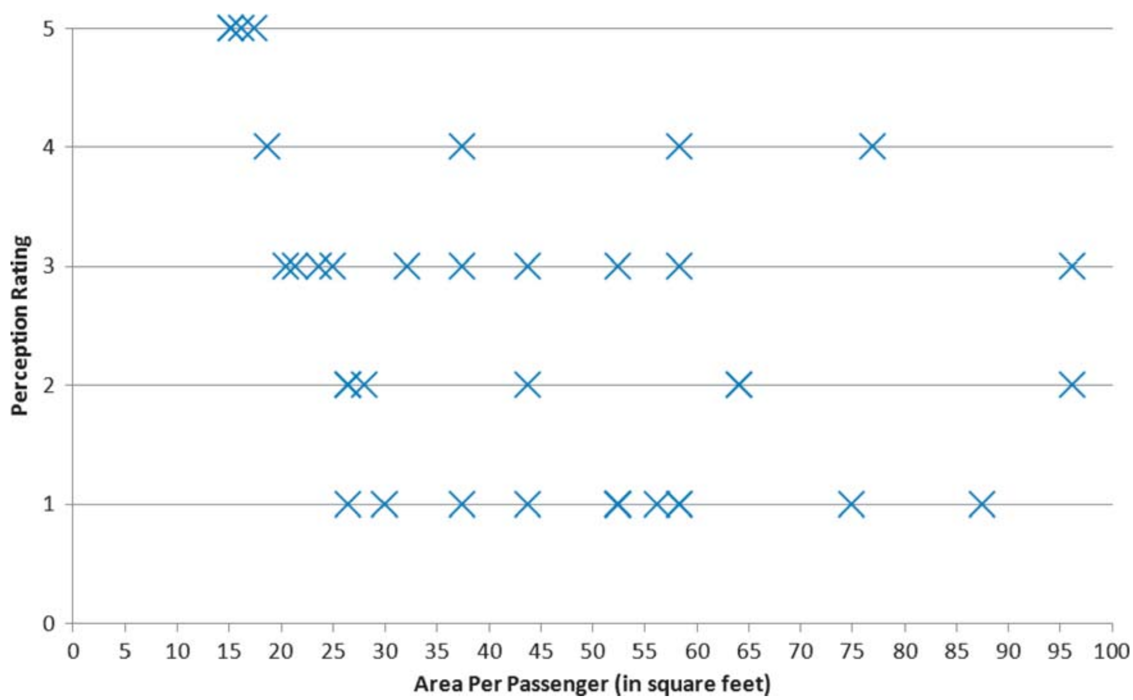


Figure B9. Perception ratings for agent check-in process by area per passenger.

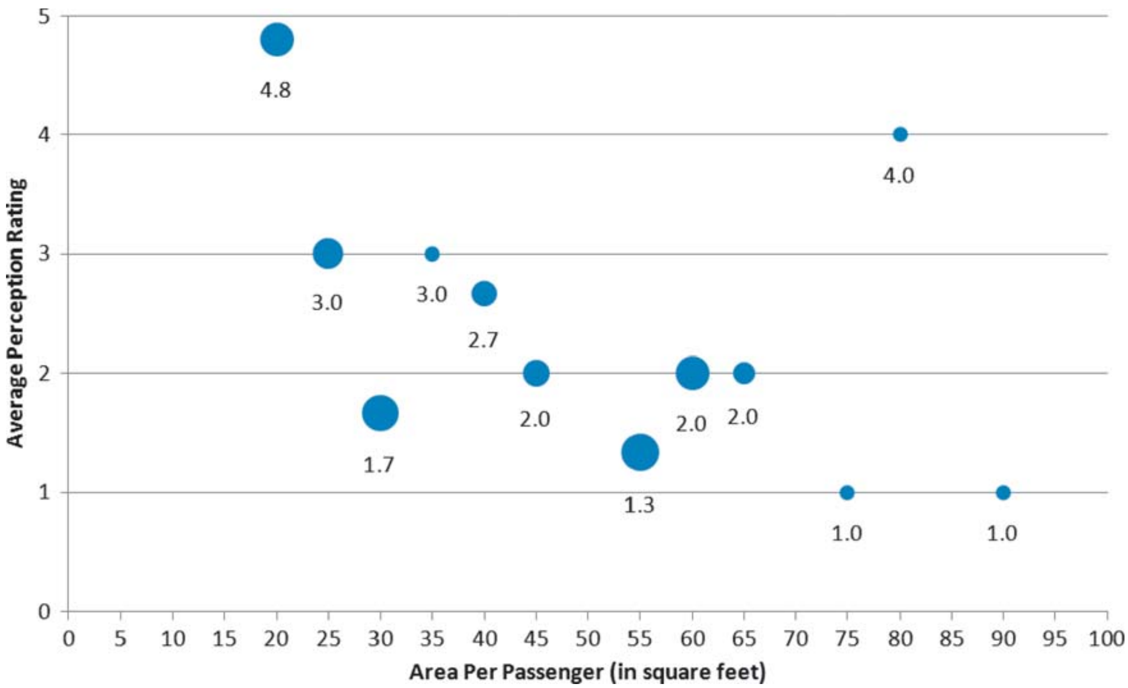


Figure B10. Average perception ratings for agent check-in process by area per passenger.

Table B5. Results for test conditions for agent check-in based on area per passenger.

Test Condition for Area	Data Group A	Data Group B	p-value	Significant Difference
Condition 1	Area ≤ 5 sq ft per passenger	Area > 5 sq ft per passenger	–	No data
Condition 2	Area ≤ 10 sq ft per passenger	Area > 10 sq ft per passenger	–	No data
Condition 3	Area ≤ 15 sq ft per passenger	Area > 15 sq ft per passenger	–	No data
Condition 4	Area ≤ 20 sq ft per passenger	Area > 20 sq ft per passenger	–	Inadequate data

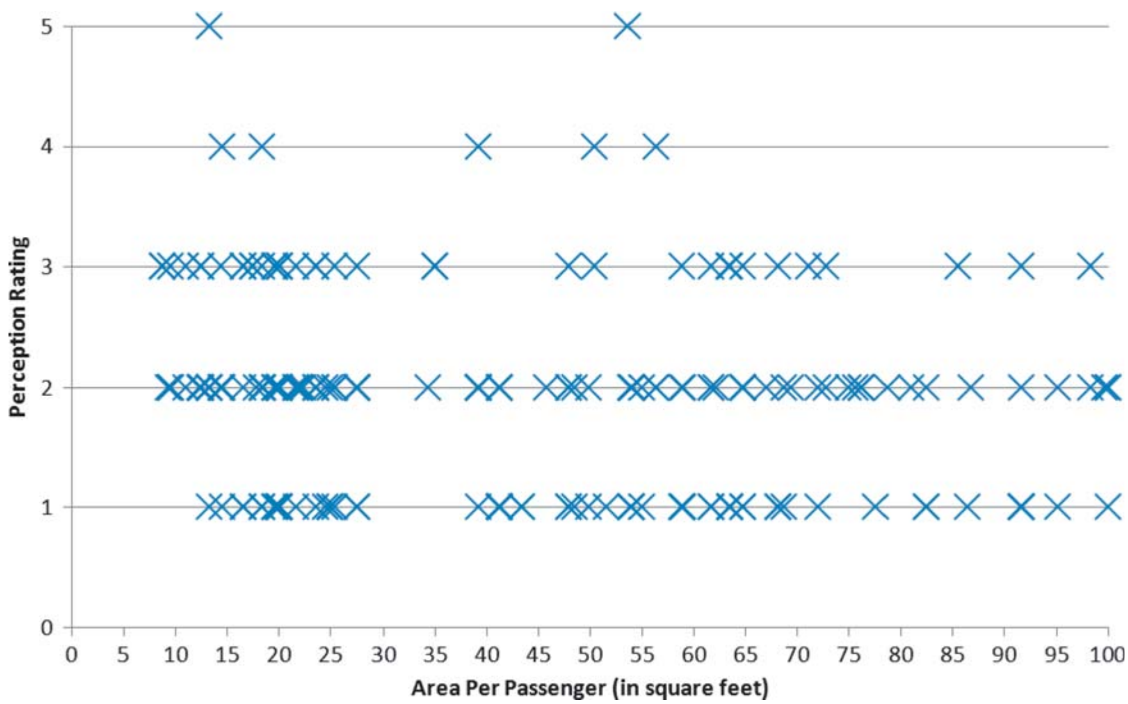


Figure B11. Perception ratings for SSCP Process by area per passenger.

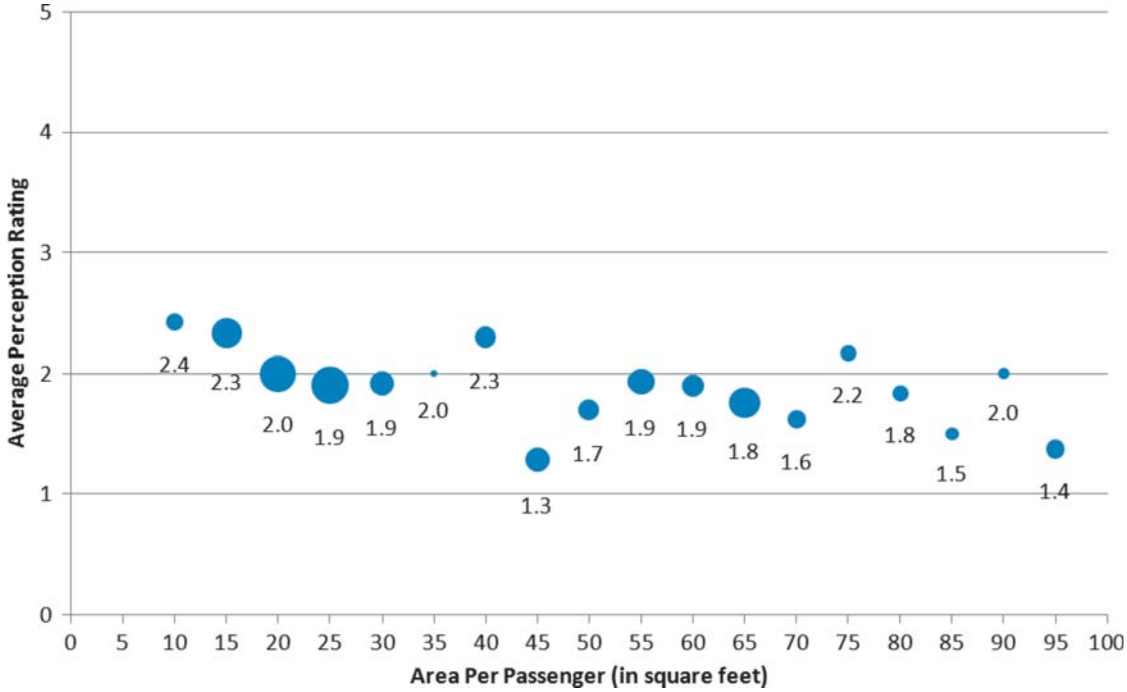


Figure B12. Average perception ratings for SSCP process by area per passenger.

Table B6. Results for test conditions for SSCP based on area per passenger.

Test Condition for Area	Data Group A	Data Group B	p-value	Significant Difference
Condition 1	Area ≤ 5 sq ft per passenger	Area > 5 sq ft per passenger	–	No data
Condition 2	Area ≤ 10 sq ft per passenger	Area > 10 sq ft per passenger	–	Inadequate data
Condition 3	Area ≤ 15 sq ft per passenger	Area > 15 sq ft per passenger	.025	Yes
Condition 4	Area ≤ 20 sq ft per passenger	Area > 20 sq ft per passenger	.034	Yes

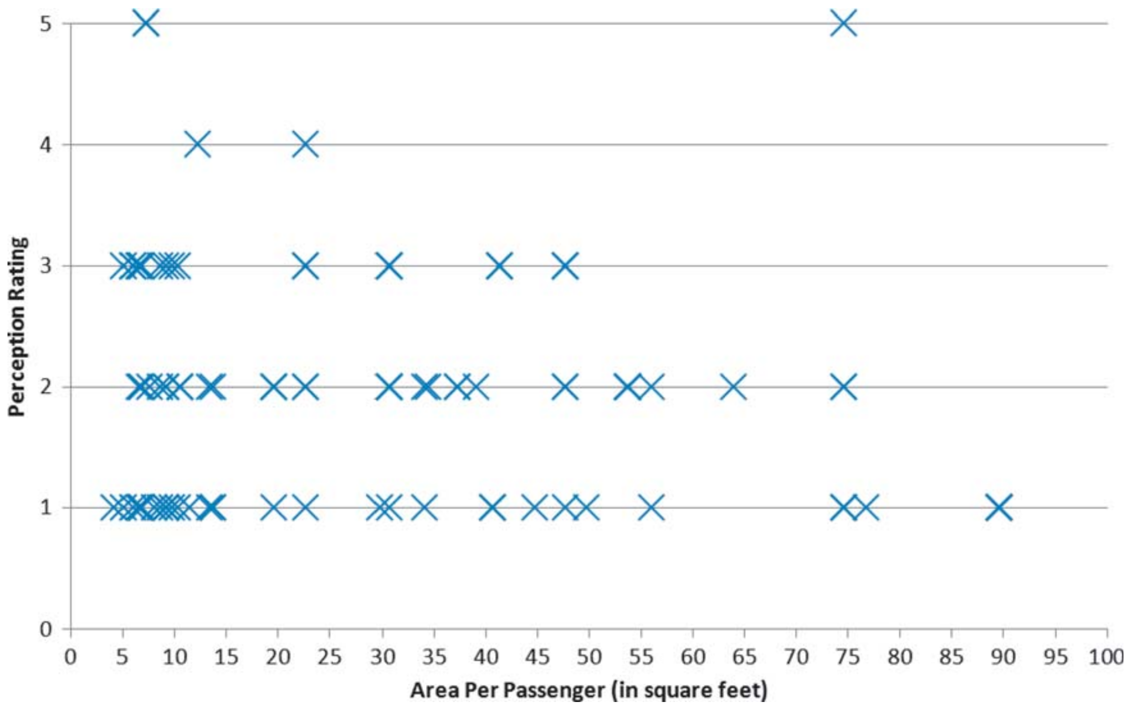


Figure B13. Perception ratings for kiosk process by area per passenger.

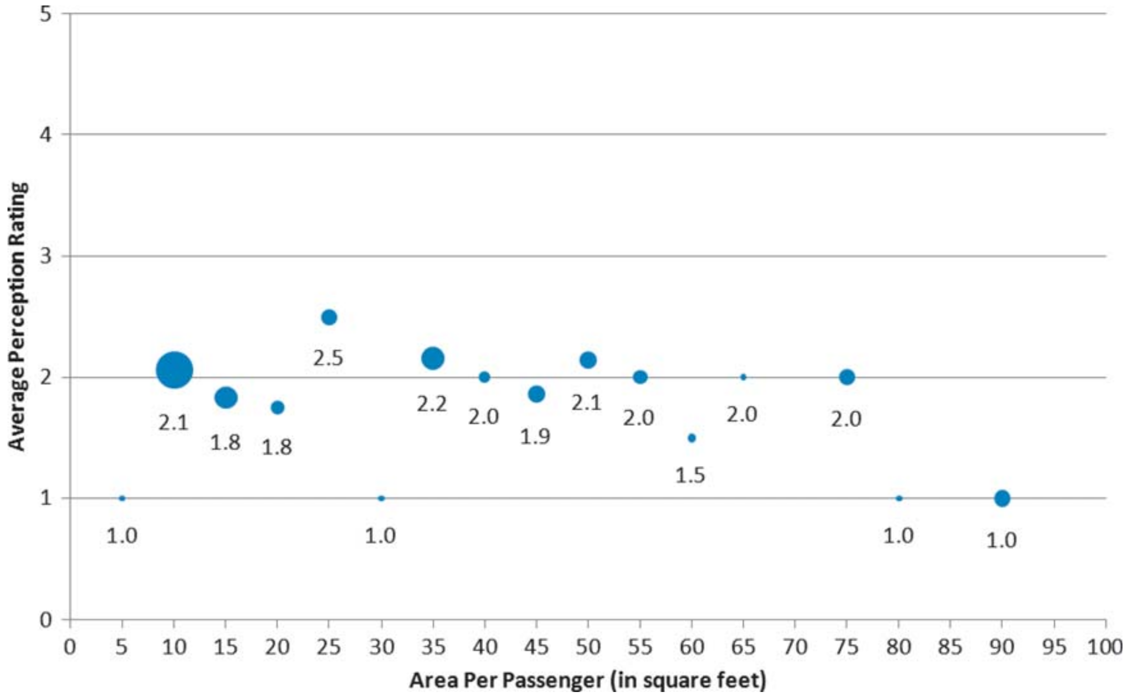


Figure B14. Average perception ratings for kiosk process by area per passenger.

Table B7. Results for test conditions for kiosk based on area per passenger.

Test Condition for Area	Data Group A	Data Group B	p-value	Significant Difference
Condition 1	Area ≤ 5 sq ft per passenger	Area > 5 sq ft per passenger	.380	No
Condition 2	Area ≤ 10 sq ft per passenger	Area > 10 sq ft per passenger	.190	No
Condition 3	Area ≤ 15 sq ft per passenger	Area > 15 sq ft per passenger	.241	No
Condition 4	Area ≤ 20 sq ft per passenger	Area > 20 sq ft per passenger	.280	No

fails to show a significant difference between area per passenger and average perception rating for four test conditions (1 through 4). This indicates no definable relationship between area per passenger and average perception rating for this function. Additionally, for all area buckets, the average perception rating generally remains better than acceptable (less than 3.0). No TP is indicated for these data.

Figure B15 shows the spread of perception data, and Figure B16 shows the distribution of average perception ratings for the corridor process collected at all airports compared to average passenger area. Each X represents at least one data point.

Table B8 shows the results for the test conditions for this functional area based on area per passenger. Statistical analysis fails to show a significant difference between area per passenger and average perception rating for four test conditions (1 through 4) since there were no data in that range. No TP is indicated for these data, but a significant relationship could exist if the data could be collected for that region of the graph.

Figure B17 shows the spread of perception data, and Figure B18 shows the distribution of average perception ratings for the bag drop process collected at all airports compared to average passenger area. Each X represents at least one data point.

Table B9 shows the results for the test conditions for this functional area based on area per passenger. Statistical analysis fails to show a significant difference between area per passenger and average perception rating for two of the four test conditions (3 and 4). There were no data available for the first two conditions, but a relationship could exist if the data could be collected for that region. Note that for all area buckets with data the average perception rating generally remains better than acceptable (less than 3.0). No TP is indicated for these data.

Figure B19 shows the spread of perception data, and Figure B20 shows the distribution of average perception ratings for the bag claim process collected at all airports compared to average passenger area. Each X represents at least one data point.

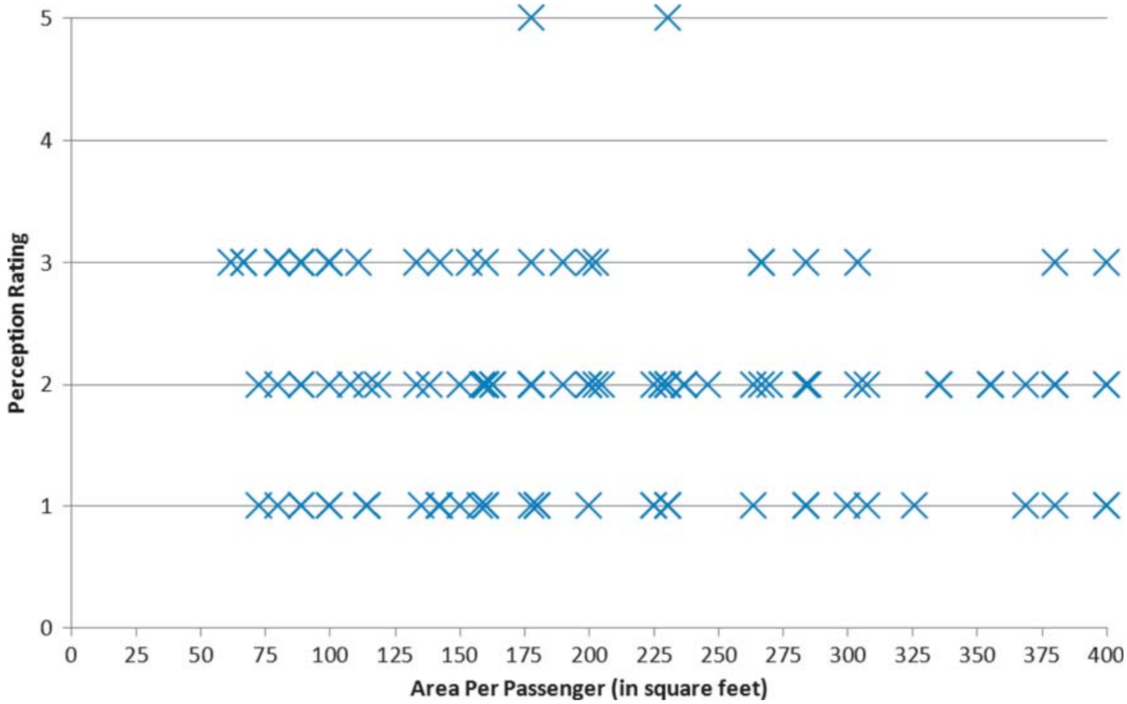


Figure B15. Perception ratings for corridor process by area per passenger.

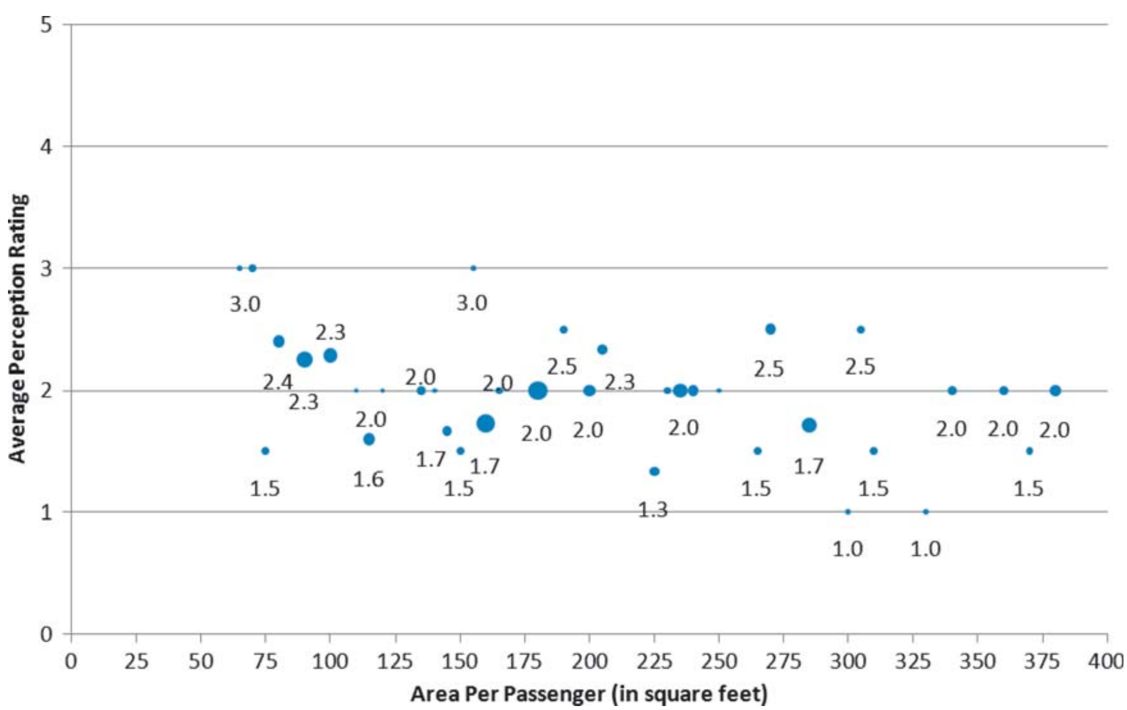


Figure B16. Average perception ratings for corridor process by area per passenger.

Table B8. Results for test conditions for corridor based on area per passenger.

Test Condition for Area	Data Group A	Data Group B	p-value	Significant Difference
Condition 1	Area ≤ 5 sq ft per passenger	Area > 5 sq ft per passenger	–	No data
Condition 2	Area ≤ 10 sq ft per passenger	Area > 10 sq ft per passenger	–	No data
Condition 3	Area ≤ 15 sq ft per passenger	Area > 15 sq ft per passenger	–	No data
Condition 4	Area ≤ 20 sq ft per passenger	Area > 20 sq ft per passenger	–	No data

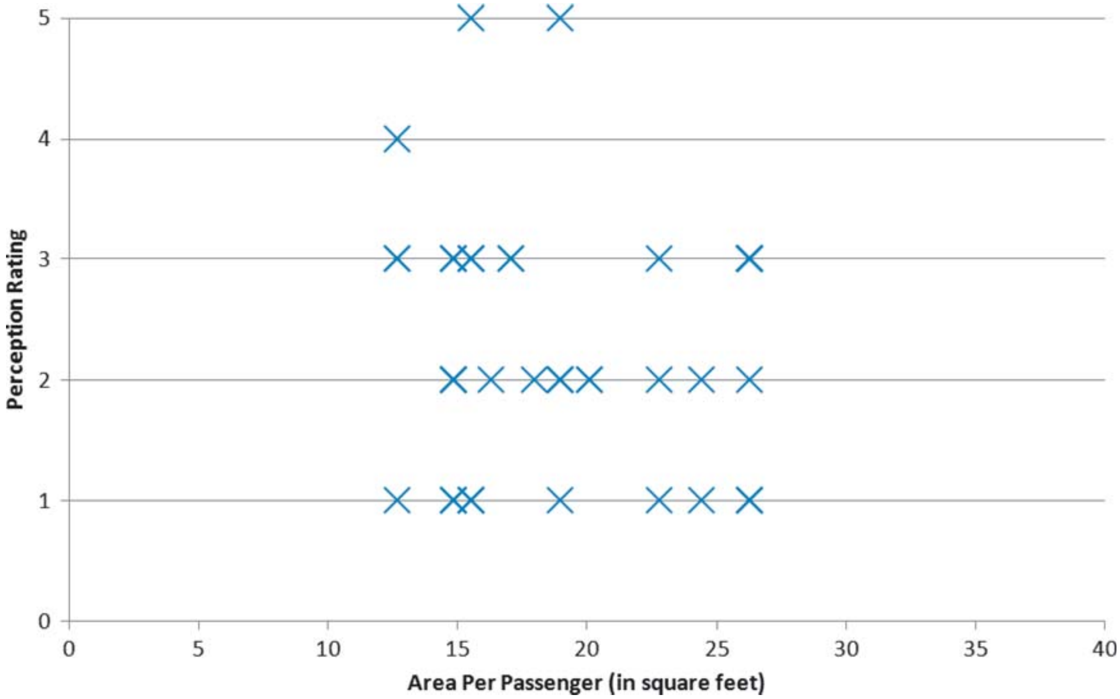


Figure B17. Perception ratings for bag drop process by area per passenger.

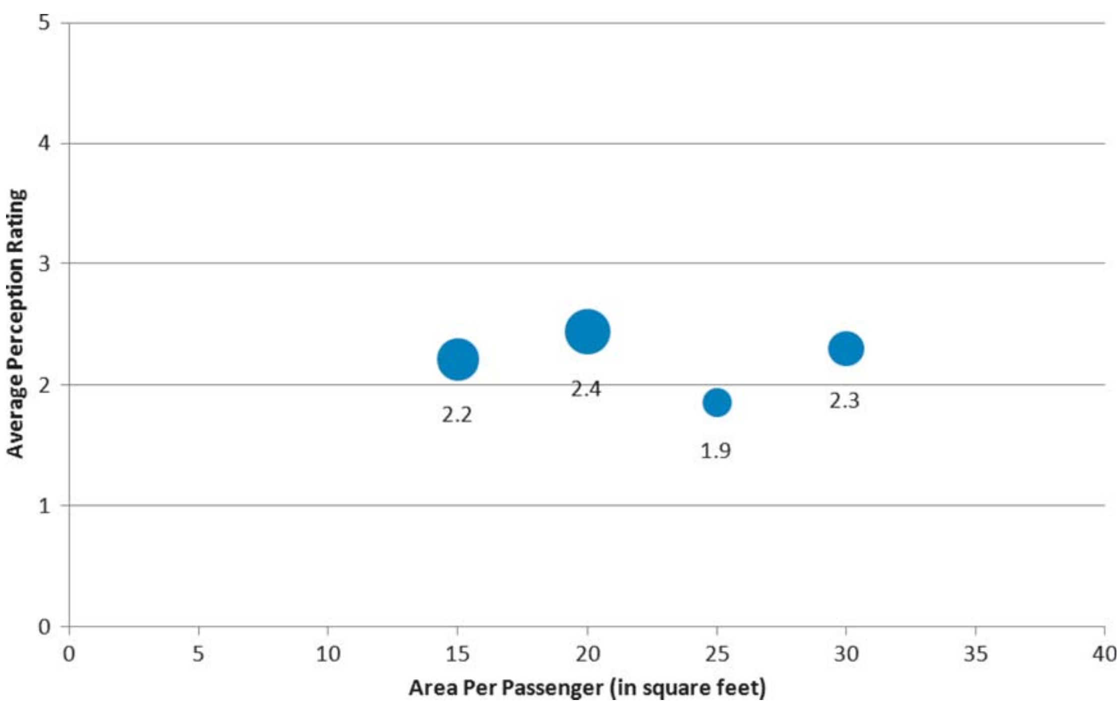


Figure B18. Average perception ratings for bag drop process by area per passenger.

Table B9. Results for test conditions for bag drop based on area per passenger.

Test Condition for Area	Data Group A	Data Group B	p-value	Significant Difference
Condition 1	Area ≤ 5 sq ft per passenger	Area > 5 sq ft per passenger	–	No data
Condition 2	Area ≤ 10 sq ft per passenger	Area > 10 sq ft per passenger	–	No data
Condition 3	Area ≤ 15 sq ft per passenger	Area > 15 sq ft per passenger	.891	No
Condition 4	Area ≤ 20 sq ft per passenger	Area > 20 sq ft per passenger	.553	No

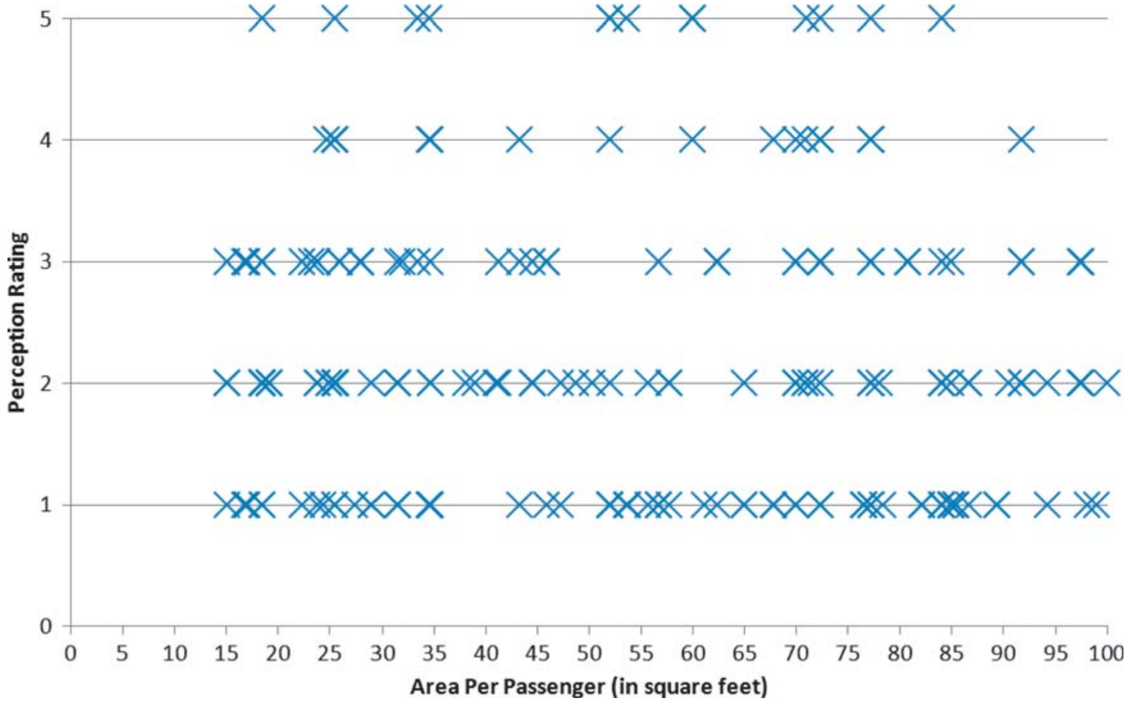


Figure B19. Perception ratings for bag claim process by area per passenger.

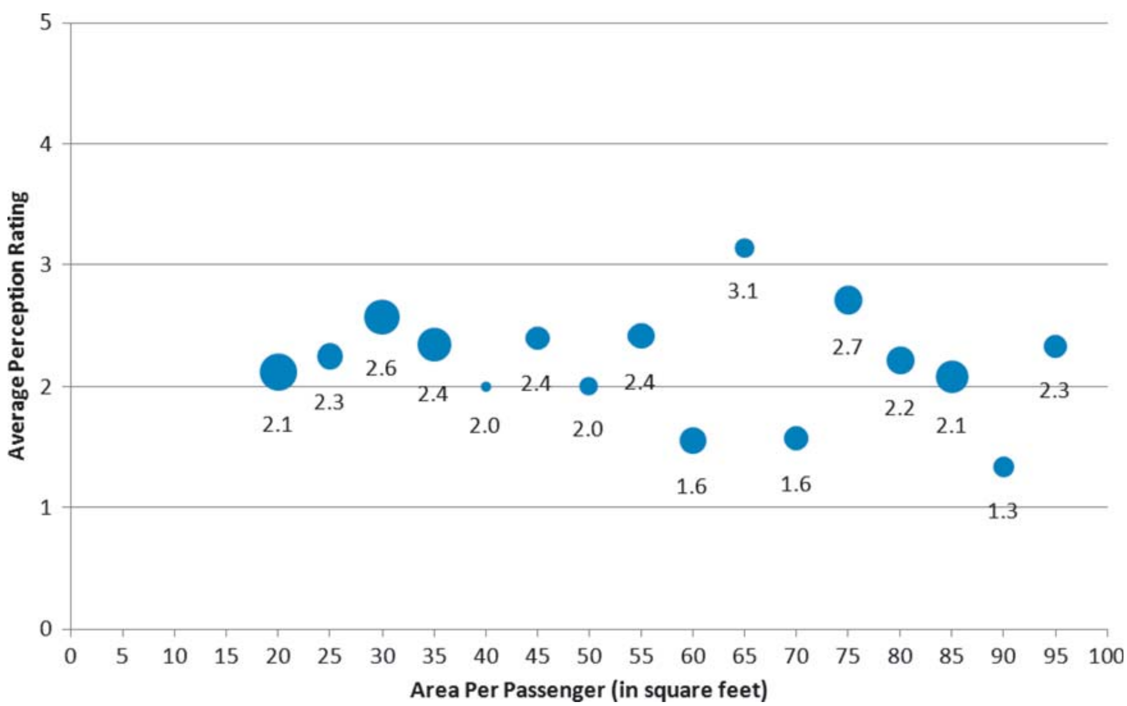


Figure B20. Average perception ratings for bag claim process by area per passenger.

Table B10. Results for test conditions for bag claim based on area per passenger.

Test Condition for Area	Data Group A	Data Group B	p-value	Significant Difference
Condition 1	Area ≤ 5 sq ft per passenger	Area > 5 sq ft per passenger	–	No data
Condition 2	Area ≤ 10 sq ft per passenger	Area > 10 sq ft per passenger	–	No data
Condition 3	Area ≤ 15 sq ft per passenger	Area > 15 sq ft per passenger	–	No data
Condition 4	Area ≤ 20 sq ft per passenger	Area > 20 sq ft per passenger	.610	No

Table B10 shows the results for the test conditions for this functional area based on area per passenger. Statistical analysis fails to show a significant difference between area per passenger and average perception rating for the fourth test condition. There were no data available for the first three conditions (1 through 3), but a relationship could exist if the data could be collected for that region. Additionally, for all area buckets, the average perception rating generally remains better than acceptable (less than 3.0). No TP is indicated for these data.

APPENDIX C

Observations, Comments, and Suggestions by Passengers

Ticketing

- Curbside service is not well understood or used due to charges—how much does it cost?
- Line management in ticketing and kiosk areas are a necessity during peak times.
- Too many kiosks in random locations are confusing—"what are these machines for"—if not co-located with an airline.
- Shift changes and reduction in number of airline agents during peak times with long lines were particularly confusing/frustrating. This issue was also noticed with TSA agents at security checkpoints.
- Better communication would ease confusion and anxiety. For example, announcements regarding certain situations:
  - "Why is this line so long?"
  - "Will I make my flight?"
  - "What is the status/cause of flight delay?" (weather, crew, aircraft, and so on).
  - "Will I make my connecting flight?"
  - "Do I have to stand in line and do I lose my place in line if I need to step away?"
  - "What is the anticipated wait time?"

Security

- Having a pre-security area for beverages/snacks was appreciated by meeters/greeters and created a better perception—especially those that were in viewing distance of the SSCP.
- Better communication pre-security providing information such as where to find medical-related appliances, wheelchairs, and so forth.
- Better definition of what is considered "handicapped" in an airport: (e.g., physical issues, traveling with children, pregnant, elderly).
- Better definition of security-related categories: "expert travelers" versus "casual travelers." The "expert" TSA lane had a club-like presence, and those travelers seemed to be willing to wait longer if it separated them from families traveling together. "Casual" was not well understood by some passengers.

Gate Areas

- Televisions in gate areas received mixed reviews: some travelers did not like them since they could not control the volume or alter seating for viewing; others liked them as long as they had the news and closed-captioning; some thought they were useless and would prefer music; seating for viewing seemed to be the most important issue.
- Being cut off from news to wait at the airport bothered some—suggested news feeds in some manner.
- TVs at a lower height and tuned to children-friendly channels would entertain younger travelers.
- Seat heights and comfort could be improved. Low seats make it difficult for heavier, taller, or older passengers to get up/down; hard seats are too uncomfortable to sit in for long periods; a way to prop up legs or better prepare seats for sleeping would be preferred.
- Electrical outlets near seating are appreciated.
- Better communications regarding Wi-Fi connectivity: signage to state if it is free or has a charge, who the carrier is—in case a passenger subscribes to a specific Wi-Fi provider.
- Location of agent computer terminal: does the screen reflect in windows or décor behind it so that others may see information?
- Location, quantity, and cleanliness of trash cans are important—including receptacles near gate in holdroom so that passengers can discard food/beverages before boarding.
- Better communication and method for delivering announcements designed to go to seating area only—not hallways. Also, clarity of announcement (enunciation) is imperative so that passengers readily understand communication.

Facilities

- Deeper/larger bathroom stalls allowing rolling carry-on luggage or a small stroller inside with occupant were appreciated.
- Location of directional signage: when placed too high caused confusion and congestion at some airports.
- The location of the FIS once on the secured side made all the difference in congestion just beyond the composition point of SSCP. If too close, a passenger backup occurred.
- A clean, well-lit (windows/natural light), and climate-controlled airport was noticed and appreciated. Passengers also appreciate local flare in décor of airports.
- Flooring considerations: attention to carpeting versus other types of flooring in terms of ease in rolling luggage and strollers should be taken.
- Restaurants should be well ventilated so that food odors do not permeate into the hold areas.
- Child entertainment areas, with sanitizing wipes, were suggested.
- Carpeting: next to the windows was nice for toddlers and kids to play/watch planes. Likewise, if passengers need to sit on the floor because of lack of seats and announcements are made only in gate area, carpeting is preferred.

Concessions/Tenets

- Seating in restaurant areas should better accommodate luggage so that placement choices minimize frustration of fellow passengers.
- Better signage and communication to access the rental car area so as to inform of most direct, time-efficient route.

Miscellaneous

- Calm and relaxing acoustic music throughout airport was suggested.
- Uniforms identifying personnel's roles would be useful/helpful.

Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation