

Task 2 Technical Memorandum: Airport Terminal Design Related  
Research Gaps and Recommendations to Address Research Gaps

INTERIM DELIVERABLE

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## Executive Summary

Our review identified up to eight problem statements that we will refine and update as the project progresses. We also found that ACRP has used an effective approach of leveraging the findings and recommendations from past research to guide future studies. In addition to the problem statements identified and to be refined during this study, our key recommendations are that:

- ACRP apply the same approach used to build up the body of knowledge in ‘airport sustainability’ research to airport terminal design research.
- We found ACRP Report 25 to be the most expansive document related to airport terminal design, touching on almost every topic related to airport terminal design. We propose ACRP use it as a starting point and build it into comprehensive resource on airport terminal design around it. For a start, the AV050 Airport Terminal and Ground Access committee could be asked to explore the feasibility of building Report 25 into a comprehensive manual comparable to the Highway Capacity Manual. The manual can be updated periodically (say every five or ten years). In between updates ACRP can developed focused studies that will feed into the manual to ensure its contents are relevant to state-of-the-practice.
- We recommend ACRP leverage its Impact on Practice reports as a tool to assess how industry is using their products (especially when software tools are developed during studies).

We look forward to receiving input and feedback from the panel and ACRP on this Task 2 memorandum.

# 1 Introduction

This Task on Identification and Prioritization of ACRP Research Gaps aims to address two of the objectives of ACRP 07-15, mainly:

- Assess and determine which of the related ACRP documents need updating or consolidating (in priority order). If updates or additional research are needed, create new research problem statements for future consideration.
- Recommend a process for keeping related ACRP-published documents updated including this searchable library.

The outcome of this task will be incorporated into the final project deliverables. Specifically, the requirements for a *“(2) stand-alone a report that includes (a) an assessment of related ACRP reports that need update or consolidation; (b) new research problem statements for those updates of ACRP reports and any additional research needs identified; and (c) recommendation of a process for keeping related ACRP-published reports updated including this searchable library.”*

## 2 Gaps in ACRP Terminal Design Research Products

We used the prioritized list of relevant ACRP terminal design documents from Task 1 as a starting point for the gap analyses.

- All ACRP documents that were ranked 1 during Task 1 were reviewed in detail during the gap analysis.
- ACRP documents ranked between 1 and 2 were re-reviewed and those found relevant were selected for inclusion in the gap analysis.
- We also included a few that ranked above 2 during Task 1, based on our judgment and expertise.

The key difference between the Task 1 and Task 2 reviews are that all reports selected for review in Task 2 were read in full, by team members that were best suited to evaluate the technical content. A written report was developed that includes a brief overview, review, and recommendations to address gaps identified. The overview is usually the summary and preface information in the published report. Recommendations to address gaps included, updating the existing report, keeping the existing report by developing research statements to address specific topics in a separate report, consolidating reports, and also developing “ACRP Impacts on Practice” publications.

### 2.1 Review of Prioritized ACRP Terminal Design Publications for Gaps

Below is a highlight of the outcomes of the gap review process:

- 23 ACRP reports were selected for detailed review and gap analysis during this Task. The reports cover 21 studies as ACRP Report 25 and 37 each had two volumes (publications).
- We identified the need for eight research problems statements to address gaps, and drafts of the problem statements (to be refined as the project progress) are presented in Appendix B.

- We found *ACRP Report 25 Airport Passenger Terminal Planning and Design* to be the most expansive document related airport terminal design. In order to focus and grow ACRPs contribution in the field of airport terminal design we propose ACRP update this report periodically (say every 5-10 years) and incorporate content from other relevant studies.
- There are two reports, ACRP Report 130 Guidebook for Airport Terminal Restroom Planning and Design and ACRP Report 52 Wayfinding and Signing Guidelines for Airport Terminals and Landside that need to be incorporated into future ACRP Report 25 updates.
- We also recommend for ACRP to develop Report 25 into a go-to manual on terminal design, similar to the Highway Capacity Manual. Given ACRP's mandate there will be the need to collaborate with other agencies (such as FAA, ACI, NASAO) to achieve such a goal. For a start, the AV050 Airport Terminal and Ground Access committee could be asked to explore the feasibility of building Report 25 into a manual. The manual should be updated periodically, say every five or ten years, to accommodate new developments. In between the updates, ACRP can then conduct focused studies on airport terminal planning for incorporation into the manual.
- Three ACRP studies have developed tools for which we recommend ACRP conduct industry surveys to gauge level of use and adoption of tools. We suggest surveys be scoped so they can be conducted quickly and findings published as *Impacts on Practice* reports.

Table 1 lists the reports reviewed and the recommendations to address gaps identified. Full details of each review are presented in Appendix A.

#### 2.1.1 On-going ACRP Airport Terminal Design Research

As mentioned in the Amplified Work Plan our team will continue to monitor all ACRP related airport terminal design related research such as ACRP Project 02-30 Enhancing the Airport-Industry SAGA<sup>i</sup> Website during this ACRP 07-15 study. Any relevant reports will be reviewed and findings incorporated in the final project deliverables.

**Table 1: List of ACRP Publications Reviewed with Recommendations**

No.	ACRP Publication	Recommendation	# Problem Statements
1	ACRP Report 25: Airport Passenger Terminal Planning and Design - Volume 1: Guidebook (2010)	Recommend tasking AV050 to explore developing Report 25 into a Manual comparable to Highway Capacity Manual 4 Draft Problem Statements <ul style="list-style-type: none"> <li>• Resource Guide on Airport Baggage Handling Systems</li> <li>• Selection and Application of Building Materials for Passenger Terminal</li> <li>• Safe Hazardous Waste Material Handling during Airport Construction Projects</li> <li>• Planning and Designing of Low Cost Carrier Terminals</li> </ul>	4
2	ACRP Report 25 Airport Passenger Terminal Planning and Design Volume 2: Spreadsheet Models and User's Guide (2010)	1 Problem Statement <ul style="list-style-type: none"> <li>• Integrating Numerical Airport Planning Data and Building Information Modeling (BIM) Tools</li> </ul>	1
3	ACRP Synthesis Report 8: Common Use Facilities and Equipment at Airports (2008)	No updates needed.	
4	ACRP Report 30: Reference Guide on Understanding Common Use at Airports (2012)	Update periodically (2 year intervals), and consider dissemination of updates by ERL (or online resources)	
5	ACRP Report 10: Innovations for Airport Terminal Facilities (2008)	Update periodically (2 year intervals), and consider dissemination of updates by ERL (or online resources) 2 Draft Problem Statements <ul style="list-style-type: none"> <li>• Passenger Self-tagging of Baggage<sup>ii</sup></li> <li>• Bag-check Plaza configuration and Financial Feasibility</li> </ul>	2
6	ACRP Synthesis Report 10: Airport Sustainability Practices (2008)	No updates needed	
7	ACRP Report 80: Guidebook for Incorporating Sustainability into Traditional Airport Projects (2012)	No updates needed.	
8	ACRP Report 110: Evaluating Impacts of Sustainability Practices on Airport Operations and Maintenance (2014)	ACRP conduct a survey of users of the tool developed and disseminate findings using an <i>Impacts on Practice</i> document.	

No.	ACRP Publication	Recommendation	# Problem Statements
9	ACRP Report 119: Prototype Airport Sustainability Rating System Characteristics, Viability, and Implementation Options (2014)	ACRP conduct a survey to explore level of adopting of prototype rating system. Disseminate findings using an <i>Impacts on Practice</i> document.	
10	ACRP Synthesis Report 66: Lessons Learned from Airport Sustainability Plans (2015)	No updates needed.	
11	ACRP Synthesis Report 51: Impacts of Aging Travelers on Airports (2014)	Additional interviews needed to make determination of need for updates/problem statements.	
12	ACRP Report 130: Guidebook for Airport Terminal Restroom Planning and Design (2015)	Report needs selective updates, but not immediately. Updates and contents should be incorporated into ACRP Report 25.	
13	ACRP Report 55 Passenger Level of Service and Spatial Planning for Airport Terminals (2011)	Three focus areas identified and being refined into problem statements 1-3 Draft Problem Statements on “Validating Passenger Level of Service and Spatial Planning Criteria for Airport Terminals.” Topics being considered include: <ul style="list-style-type: none"> <li>• Using ethnographic data collection techniques to understand passenger perceptions inside an airport terminal.</li> <li>• Ethnographic surveys to understand how perceived LOS is affected by factors that contribute to a reduction of passenger stress</li> <li>• New data collection survey techniques to expedite passenger response rates and to track passengers around the terminal.</li> </ul>	3
14	ACRP Report 37 Guidebook for Planning and Operations of Automated People Mover Systems at Airports (2010)	No updates needed.	
15	ACRP Report 37A Guidebook for Measuring Performance of Automated People Mover Systems at Airports (2012)	No updates needed.	
16	ACRP Report 41: Guide to the Decision Making Tool for Evaluating Passenger Self Tagging (2011)	(See problem statement for ACRP Report 10).	
17	ACRP Report 117: Airport Escalators and Moving Walkways Cost Savings and Energy Reduction Technologies (2014)	No updates needed.	

No.	ACRP Publication	Recommendation	# Problem Statements
18	ACRP Report 61: Elimination or Reduction of Baggage recheck for arriving international passengers (2012)	Periodic updates needed but not immediately (suggest every 5 years)	
19	ACRP Report 54: Resource Manual for Airport in Terminal Concessions (2011)	No updates needed now. Synthesis on un-conventional terminal concessions could be explored in the future, as many airports are exploring options. <sup>iii</sup> .	
20	ACRP Report 96: Apron Planning and Design Guidebook (2013)	No updates needed.	
21	ACRP Report 52: Wayfinding and Signing Guidelines for Airport Terminals and Landside (2011)	No updates needed. ACRP should consider dedicating a chapter for this topic in ACRP Report 25.	
22	ACRP Report 109: Improving Terminal Design to Increase Revenue Generation Related to Customer Satisfaction (2014)	No updates needed.	
23	ACRP Report 40: Airport Curbside and Terminal Area Roadway Operations (2010)	ACRP conduct survey to find out level of use of software tool developed. Disseminate finding using <i>Impacts on Practice</i> document.	

## 2.2 Addressing Gaps in ACRP Airport Terminal Design Research

ACRP currently has a well-defined process to keep research topics updated and relevant. ACRP on most studies requires consultants to develop topics for further research in their final reports, and ACRP has used this information to guide further research. A great example is the sustainability related ACRP publications to date:

- *ACRP Synthesis 10 Airport Sustainability Practices* in 2008 serves as a kickoff study to understand how airports were implementing sustainability initiatives.
- *ACRP Report 80 Guidebook for Incorporating Sustainability into Traditional Airport Projects*, published in 2012, builds on Synthesis 10 findings and recommendations to develop guidelines for airport that wanted to incorporate sustainability but were not sure where to start.
- In 2014, *ACRP Report 119 Prototype Airport Sustainability Rating System Characteristics, Viability and Implementation Options*, which builds on Report 80 and develops a framework of metrics airports could use for measuring and tracking their sustainability initiatives.
- In the same year *ACRP Report 110 Evaluating Impacts of Sustainability Practices on Airport Operations and Maintenance* was released. Report 110 developed a cost-benefit analysis tool to assist operations and maintenance teams evaluate sustainability practices, techniques and equipment purchase.
- Finally, in 2015, *ACRP Synthesis 66 Lessons Learned from Airport Sustainability Plans*, begins to explore sustainability options for smaller airports that were not covered in sufficient detail in the three prior studies.
- ACRP Project 02-30 is on-going and due to be completed early 2016. The outcome will add-on to the 5 studies above. The objectives of 02-03 are to (1) improve and enhance the SAGA website and (2) provide recommendations for maintaining and updating the SAGA website and its sustainable practices contents over time. Improvements and enhancement to the SAGA website should include updating existing sustainable practices data--including new practices--and identifying, vetting, and populating additional supporting information for each of the sustainable practices provided.

The approach is very effective and we recommend ACRP use that for airport terminal design related research also, with Report 25 as the focus. We also note that the ACRP Oversight Committee that guides selecting of new research topics is staffed with leading edge researchers and practitioners that can guide the selecting of new, emerging and relevant research areas.

The areas our team identified for adding value to the process is mainly related to dissemination of the ACRP products:

- **Online Visibility:** Given the continuing trend of users accessing information electronically rather than ordering publications, with time most of ACRP's content will be downloaded from the web. As ACRP develops ERLs, the agency needs to explore services such as Web Analytics and Search Engine Optimization features to ensure research agency is publishing is getting to the target audience.
  - *Web Analytics* is usually a paid service where a search engine such as Google provides compiled metrics on how many times a site is visited and if and when documents have been downloaded. Information on how frequently specific

reports are being downloaded could be an additional tool for ACRP to measure level of use of their products, and level of interest in specific topics.

- *Search Engine Optimization* tends to focus more on designing a website to ensure the site shows up when related searches are performed in Google, Bing or other search engines. The goal of this is to ensure ACRP's target audience (and a wider audience) is well informed on related products when they are not necessarily conducting a search at TRB or ACRP web portal. Having ACRP documents highlighted in general searches will complement the Web Analytics capability, and further help ACRP identify which of its products are relevant. This information can be used complement existing processes used to identify topics of interest to the aviation community.
- **Impacts on Practice:** we found the information in current ACRP Impacts on Practice publications to be very enlightening but it is not clear how much the industry in general is aware of these publications. We recommend ACRP invest in more of these studies, especially as tools to evaluate how industry is using their products (especially when software tools are developed during studies).
- **Outreach Programs:** other outreach programs ACRP can leverage to ensure information from ACRP publications are publicized, while at the same time gaining feedback from users on which are relevant, are the Ambassadors Program and ACRP Webinars. We did not evaluate these programs during Task 2, but will collect additional information by the end of this project.

### 3 Summary and Conclusions

Our review has identified up to eight problem statements that we will refine and update as the project progresses. There will be two check points with the project panel related to this task.

- The first will be during the Interim Report (and the Panel Meeting) when we will provide updated versions of the problem statements and discuss with the panel any new additional findings
- After the panel meeting, we will continue to revise and update our review of problem statements as other relevant ACRP publications are released and submit a finalized gap analysis in the draft project deliverables.

We also found that ACRP appears to be leveraging the findings and recommendations from past research to guide future studies. That approach is very effective as shown by the 'sustainability' related research products documented in this memo.

In addition to the problem statements identified and to be refined during this study, our key recommendations are that:

- ACRP apply the same approach used to build up the body of knowledge in 'airport sustainability' research to airport terminal design research.
- Given that ACRP Report 25 is the most expansive document related to airport terminal design, and touches on almost every topic related to airport terminal design, we recommend ACRP use it as a starting point and build a comprehensive resource on airport terminal design around it. As a start the AV050 Airport Terminal and Ground

Access committee could be asked to explore the feasibility of building 25 into a comprehensive manual comparable to the Highway Capacity Manual. The Manual can be updated periodically (say every five or ten years). In between updates ACRP can develop focused studies that will feed into the Manual to ensure its contents are state-of-the-art.

- We recommend ACRP leverage its Impact on Practice reports as a tool to assess how industry is using their products (especially when software tools are developed during studies).

We look forward to receiving input and feedback from the panel and ACRP on this Task 2 memorandum.

## **4 Appendix A: ACRP Publications Reviewed**

## 4.1 ACRP Report 25: Airport Passenger Terminal Planning and Design - Volume 1: Guidebook (2010)

### 4.1.1 Overview

ACRP Report 25 was developed as a comprehensive resource to address the airside, terminal building and landside components of airport passenger terminal design process. The purpose of this Guidebook is to provide a single and focused resource of information on planning and design for planners and designers of airport terminal buildings in United States. It also acts as a supplement to IATA and FAA Design guidelines. The report covers a wider range of topics related to terminal planning and design with varying degrees of detail.

ACRP Report 25 is the result of two separate research projects, “ACRP 07-04 Spreadsheet Models for Terminal Planning and Design” and “ACRP 07-05 Airport Passenger Terminal Planning Guidebook.” The products of the research were two reports Volume 1 & 2. The review is for the Volume 1 report which describes the passenger terminal planning process and provides the important criteria and requirements needed to address emerging trends and create solutions for airport passenger terminals. The Volume 1 report addresses the airside, terminal building, and landside components of the terminal complex. Volume 2 consists of a CD containing 11 spreadsheet models and a User’s Guide to assist the user in the correct use of each model.

### 4.1.2 Review

The Volume 1 report identified a wide range of criteria airport terminal designers and planners need to consider, including:

Programmatic parameters	LOS performance standards and demand/capacity assessments
Terminal facility requirements	Ticketing/check-in, Passenger screening, Holdrooms, Concessions, Baggage claim, Circulation, Airline offices and operations areas, Baggage handling, Baggage screening system, International facilities, Federal Inspection Services, Support areas, Special requirements, and Building systems
Flow sequences	Passengers, Visitors, Employees, Baggage, Deliveries, Waste removal
Passenger movements	People mover systems, Passenger way finding and signage
Terminal concept development	Domestic and international terminals, Concourse configurations, Centralized and decentralized terminals, Single vs. multi-level terminals, Flexibility and efficiency, Common-use terminal equipment, and Swing gates

### 4.1.3 Gaps and Recommendations

Report 25 covers a wide range of topics on airport planning in various degree of detail. We have identified the following topics that could benefit from additional more in-depth:

Subject	Analysis	Recommendation
Baggage Handling System Planning	Report 25 along with information in other ACRP Reports (10, 30, 41, 52, 61), provides information related to baggage handling systems planning. However, considering the complexity of baggage handling systems and the evolving technologies related to these systems, an ACRP study focused on baggage handling in addition to existing resources will be helpful to planners and designers.	Independent ACRP Report
Building materials and finishes	Today's terminal uses wide range of materials and finishes. A separate report with details about their selection criteria, acoustical properties, sustainability aspects, building code requirements, regional preferences, maintenance, Lifecycle Cost analysis, Storage and disposal, will be useful to designers.	Independent ACRP Report
Hazardous Material and its removal	Majority of terminal work in US is either renovation or addition of existing facilities built before the 1980 (Asbestos ban). A synthesis report with detailed information about identification of hazardous material and its safe removal, selection of contractors and associated costs, with their impacts on terminal construction schedule and cost is needed.	ACRP Synthesis
Low Cost Carriers (LCC) terminal Planning	With their high passenger volumes, low-cost carriers need substantial terminal space requirements while managing construction and maintenance costs low. A synthesis report explaining differences between planning requirements for LCC terminal and that of legacy carrier will be helpful resource for planners and designers.	ACRP Synthesis

Problem statement for each of the topics is presented in Appendix B of this Memo.

A key finding of our review was that ACRP consider expanding on developing Report 25 so it could serve as a go-to manual and resource for the aviation community on airport terminal design, similar to the role the Highway Capacity Manual plays for roadways. ACRP will have to collaborate with other agencies such as the FAA, ACI, NASAO, and other agencies to achieve this. A good starting point will be to task AV050 Airport Terminals and Ground Access to explore the feasibility of such a document. The expanded document should cover not just terminal design but also all the landside facilities (especially roadways and parking).

## 4.2 ACRP Report 25 Airport Passenger Terminal Planning and Design Volume 2: Spreadsheet Models and User's Guide (2010)

### 4.2.1 Overview

Volume 2 of Report 25 was developed to supplement Volume 1. It consists of spreadsheet models to perform numerical calculations for various key terminal design related processes. Users can input standard industry criteria and information which the models then use to compute estimates such as design hour capacity and space required for major terminal areas.

The report consists of “1) spreadsheet models, which include practical learning exercises and several airport-specific sample data sets to assist users in determining appropriate model inputs for their situations, and 2) a User's Guide to assist the user in the correct use of each model. The models include such aspects of terminal planning as design hour determination, gate demand, check-in and passenger and baggage screening, which require complex analyses to support planning decisions.”

### 4.2.2 Review

The models in the spreadsheets are very thorough and provide essential tools for planners and programmers that need to conduct basic analysis related to terminal design. The spreadsheet models along with user's manual in report, provides comprehensive understanding about the “numbers” required for programming, terminal planning and the logic behind it. This report augments the information about terminal planning components, discussed in Volume 1. The spreadsheet models gives planners, basic understanding about how the planning calculations for terminal are done in real world.

The Report provides the thought process behind the models and explains the following key components explored in spreadsheet models.

Available data Checklist	Data Input needed to calculate requirements in subsequent models
Design Hour demand	To find out peak hour - avg. day - peak month passenger demand. Starting point of calculations, are available seats and load factor. the information is used for other capacity calculations
Gate Demand	Calculates number of gates required based on Design Day Flight Schedule or total emplacement and total departures on design day.
Terminal components	Curb capacity, Baggage checking/ ticketing, Security Screening Check point, Hold room, Bag claim, and Customs and Border Protection

### 4.2.3 Gaps and Recommendation

The report has a Building Information Modeling (BIM) tool. BIM is essentially a digital three dimensional model of a building that contains all the information of its components. This is a very powerful way of analyzing the building for spatial quality, cost, solar study, heat gain and loss and other building systems requirements in advance that ultimately helps optimizing construction schedule and budget. These Models can also be used for maintenance and automation of building systems.

The numbers derived from the spreadsheets in the BIM tool are very valuable and provide users a good starting point for further development. However, the information extrapolated, can be used to further develop volumetric graphical models that can lead to a schematic design.<sup>iv</sup> A problem statement in Appendix B, explores how the work model developed in the ACRP study could be further extended to interface with BIM tools that architects and designers use frequently.

## 4.3 ACRP Synthesis Report 8: Common Use Facilities and Equipment at Airports (2008)

### 4.3.1 Overview

*ACRP Synthesis Report 8 Common Use Facilities and Equipment at Airports* investigated the implications of deploying common use technology in airport terminals to more efficiently utilizing space that is normally exclusive to a single airline, by making space or equipment available for use by multiple airlines. Common use is presented as a fundamental shift in the philosophy of airport space utilization, allowing the airport to increase capacity without necessarily constructing new gates, concourses, terminals, or check-in counters due to the increase in efficiency gained by shared use. The stated goal of the study was to “help airport operators, airlines, and other interested parties gain an understanding of the progressive path of implementing common use, noted as the common use continuum.”

### 4.3.2 Review

The synthesis identified a range of technologies and their benefits and impacts on both airlines and airports. The greatest benefit of common-use to airport is more efficient utilization of existing airport space. Airline also benefit from reduced operating costs of operating at the airport and flexibility in entering and leaving an airport market. According to the synthesis “Results of an interview with Lufthansa Systems revealed that CUTE (Common Use Terminal Equipment) sites can be 35% to 50% less expensive to start up, support, and maintain than proprietary sites. Despite the benefits airlines do not always support common-use initiatives for a variety of reasons including, loss of direct control of their exclusive resources (such as terminal gates), they also lose control over quality of systems installed and costs of those systems, in addition they have to configure their existing enterprise IT systems to operate within that of an airport specific IT system. Security implications of compromised shared IT platforms are also a concern expressed by airlines. It is worth mentioning that passengers could be impacted by common use system. As an example, in the case of a ‘self-check in kiosk’, navigating to the appropriate airline interface may be a challenge for a passenger that is not tech savvy.

### 4.3.3 Gaps and Recommendations

The ACRP study identified the topics below for further study:

1. Complete a Full Common Use Continuum Analysis — this synthesis generally defines the common use continuum and gives it a high-level overview. It is recommended that a full analysis of the common use continuum be performed.
2. Prepare a Cost/Benefit Analysis Template — creation of a cost/benefit analysis template could enable both airport operators and airlines to review the benefits of a common use strategy.
3. Establish a Common Use Knowledge Base and Users Group — the amount of information available to educate and share on common use is limited.
4. Prepare a Common Use Design and Implementation Guide — IATA has created a Common Use Self-Service (CUSS) implementation guide that can be of assistance to airports wanting to implement CUSS.
5. Establish Best Practices in Support and Maintenance — support and maintenance of common use strategies and solutions are important to their success and require best practices research.

6. Develop a Funding Model — airport operators need to identify sources of funding common use initiatives.

We do not recommend any additional studies at this time, because:

- A follow-up study in 2010, ACRP Report 30 *Reference Guide on Understanding Common Use at Airports* built on the synthesis and covered the first recommendation.
- Given the rapidly evolving nature of technology in the area and the leading role taking by IATA on common-use systems, our team does not recommend 2, 4, or 6 as IATA is already working on those topics.
- Establishing a user group is good idea, but with the relative ease and minimal cost required to start a blogs, online forums or social media group, the team believes is it better for an appropriate TRB Committee (AV050 Airport Terminals and Ground Access) to take the lead on recommendations 3 and 5 rather than devote ACRP resources to such an effort.

## 4.4 ACRP Report 30: Reference Guide on Understanding Common Use at Airports (2012)

### 4.4.1 Overview

*ACRP Report 30: Reference Guide on Understanding Common Use at Airports* provides a reference guide and tools that can assist airports and airlines exploring the possibility of and evaluating the appropriateness of integrating “common use” in their operations. Under ACRP Project 10-05, Barich, Inc., developed a reference guide for airports, airlines, and other stakeholders to identify and understand the financial, operational, liability, safety, customer service, and competitive elements of a common-use approach to the utilization of airport facilities and the provision of services. “Common use” most generally refers to a technological method that airlines use to process passengers: at the ticket counter, at self-service kiosks, or at the gates. However, “common use” is discussed as an operating philosophy that an airport can use in managing and administering the airport. As such, this represents a paradigm shift in the traditional tenant-landlord relationship.<sup>v</sup>

The study builds on the work accomplished in *ACRP Report 8 Common Use Facilities and Equipment at Airports*.

### 4.4.2 Review

The report discusses common-use and lays out guidelines for different technologies and environments. Some of the benefits of adopting common-use systems identified in the study include:

- Maximize Existing Facility Utilization
- Avoid or Defer Construction
- Avoid or Defer Other Capital Costs
- Maximize Facility Flexibility
- Decrease Airport Cost of Doing Business
- Decrease Airline Cost of Doing Business
- Improve Quality of Service to Airlines
- Improve Quality of Service to Passengers
- Increase Opportunities for Airlines to Add or Expand Service
- Gain a Competitive Advantage over Other Airports

As mentioned in the ACRP report preface, the implementation is a change in operating philosophy from a paradigm where different entities (say airlines) have their own exclusive environments and systems (check-in counters, gates), and control those systems to and environment in which those systems and environments are shared. In transitioning to a common-use environment the airport (usually) is taking over standardizing these systems and environments so multiple airlines can use them. This usually leads to additional costs for the airport, not just financially, but also having to develop in-house capabilities (such as managing IT systems) that otherwise were the responsibility of the airline. Airlines can also be adversely impacted as they lose some level of control of the quality of service they could provide their travelers and also have to reconfigure their proprietary systems to work within the common-use environment adopted. Finally, they also lose branding capabilities. Due to some of these factors, airlines generally prefer exclusive systems to common use systems.

The study found that in settings such as hubs, where a single airline has significant share of the terminal facilities and has invested in developing that space, it is better to target common-use

initiatives at the remaining airlines and international gates, than investing the additional effort to convince the hub carrier to adopt common-use.

Much of current common-use initiatives related to passenger processing represents a transfer of operation, management and technology cost to airport, while still aiming to meet level of service thresholds expected by airlines. Hence airports need to spend considerable time evaluating their options, planning, and most importantly building consensus with stakeholders (airlines) before embarking on common-use initiatives.

#### 4.4.1 Gaps and Recommendations

As mentioned earlier a key element in adopting the common-use environment is the cost associated in deploying and maintaining the new common-use systems (check-in kiosks, baggage tagging systems, digital signage, etc.). The rapid evolution of technology may be creating an opportunity for some of these operational and logistics costs to be transferred on passenger. Passengers are already assuming some of these self-process activities themselves. It is common for passengers these days to check-in with their phones (or computers) prior to arriving at the airport, scan in their boarding pass while going through TSA security check points with their phones, and use the same devices to scan in passes at the boarding gate. Even with the proliferation of smart phones (and accompanying apps) not all passengers technology are technology savvy, and also some passengers may just prefer to be served by an individual, so there is a need to continue to watch the trend in increased passenger self-processing capabilities, and the level of passenger adoption of these capabilities. Despite the evolving environment, it is worth exploring the impact of passenger self-processing capabilities impact (reduce) the costs of airports implementing common-use technologies in their terminals. ACRP Report 136 Implementing Integrated Self-Service at airports already covers some of the information need for such a study, and given this is rapidly evolving issue it will be more effective for ACRP to address this through a platform that could be updated frequently with minimal effort (such as the ERL in the ACRP Research project).

## 4.5 ACRP Report 10: Innovations for Airport Terminal Facilities (2008)

### 4.5.1 Overview

*ACRP Report 10: Innovations for Airport Terminal Facilities*, provides a useful synopsis of the latest worldwide developments in landside facilities design and discusses future trends and innovative passenger service/processing concepts, at the time of publication in 2008. The report describes the need for design innovations to serve and process passengers, discusses how innovation can meet many of these needs, and presents several state-of-the-industry design inventions. It explored such innovations as a process-based departure hall, self-service bag check, a drive-through processing area, elder-friendly baggage devices, alternative curbsides, and arrival lounge designs. The report will be of interest to airport operators and airport planners, architects, and engineers interested in new concepts that can stimulate design and innovation in landside facilities at airports.

### 4.5.2 Review

The report examines different futuristic solutions for airport terminal and landside areas. It explains existing procedures, identifies innovative approaches, and documents research findings. The report also analyzes existing conditions based on feedback from users during the study, and provides conceptual solutions for each issue. Each concept is analyzed in detail explaining assumptions, existing examples, and pros and cons. The following innovative ideas discussed during the study can encourage the stakeholders and planners to think outside the box about planning the terminal.

Current (in 2008)	Future
Process-based Departures Hall	Use of common-use facilities, separation of processes based on user's needs
Self-service bag checking	Passengers can tag bags and check-in on their own, integrated common-use terminal equipment (CUTE)
Low profile bag claim devices	Close to floor for ease of baggage movement and easier on aging population (and people with disabilities)
High capacity elevators	High capacity flow through elevators, used in conjunction with escalators (satisfy ADA requirements & move high volume of travelers)
Consolidated Meeters & Greeters	Consolidate area in baggage claim, and create revenue generation opportunities
Terminal layout	Re-organization of Departure and Arrival areas to optimize space while streamlining passenger flow and efficiency

### 4.5.3 Gaps and Recommendations

This report was about ideas for the future, but solutions for much of what was discussed are being implemented now. For example, some of the US airlines are already experimenting with self-service baggage checking. The report is focused on technology, which by nature evolves rapidly. Given the nature of the report ACRP may want to have report updated periodically.

## 4.6 ACRP Synthesis Report 10: Airport Sustainability Practices (2008)

### 4.6.1 Overview

*ACRP Synthesis Report 10 Airport Sustainability Practices* set out to document ongoing sustainability practices at US and non-US airports based on a literature review and web-based survey. The goal was to provide airport operators a snapshot of airport sustainability practices across the triple bottom line of environmental, economic, and social issues.

### 4.6.2 Review

The study defined sustainability along the three focus areas of:

- **Environmental practices** commonly in place at airports include measuring and monitoring water conservation, water quality, climate change, air quality, land use, biodiversity, environmentally sustainable materials, waste, noise and aesthetics, energy, and green buildings.
- **Economic sustainability practices** commonly in place at airports include local hiring and purchasing, contributing to the community, quantifying the value of sustainability practices, contributing to research and development, and incentivizing sustainable behavior.
- **Social concerns** at airports include public awareness and education, stakeholder relationships, employee practices and procedures, sustainable transportation, alleviating road congestion, accessibility, local culture and heritage, indoor environmental quality, employee well-being, and passenger well-being.

The study found that both large U.S. and non-U.S. airports consistently identified environmental sustainability practices as a priority. Smaller U.S. airports were more focused on economic prosperity. Corporate social responsibility and strategic environmental management at the governance level were key future priorities for some non-U.S. airports.

The top 5 current and future drivers of sustainability at the time of the study were:

Rank	Current (in 2008)	Future
1	State/Regional Regulations	Stakeholder Concerns/ Relations
2	Airport Policy	Global Trends
3	Federal Regulations	Airport Policy
4	Corporate Responsibility	Corporate Responsibility
5	Stakeholder Concerns/ Relations	Federal Regulations

Respondents from both U.S. and non-U.S. airports said that environmental training is offered at their airport; but economic and social sustainability training were not mentioned as often. This is not surprising as in the US the EPA issues multiple regulations that impact airport operations and decision making, while there is no specific agency that regulates the ‘social’ or ‘economic’ impacts of airport.

The study found that respondents from non-U.S. airports and large U.S. airports rated their airports’ performance higher than those from small and medium U.S. airports. Regulation and airport policy were the key drivers for the airports implementation of sustainability practices. Climate change was mentioned, but as a future rather than a current concern and driver of

sustainability practices. Funding was the predominant barrier to implementation of sustainability practices.

#### 4.6.1 Gaps and Recommendations

Suggestions for further research included in the report are:

- Use the survey results to create sustainability guidelines for airports.
- Research the three sustainability areas (environmental, economic, and social) separately and in depth.
- Ensure that governance of sustainability practices at airports targets developing a business plan and strategy for implementation.
- Partner with the Global Reporting Initiative to develop an airport sector supplement of the G3 guidelines.
- Query the airports further on their practices and create a best practice sustainability in airports document with details on where, when, how, and why airports have implemented various practices.
- Define the business case for sustainability practices.
- Link planning and capital budgeting—determine why funding was identified as the key barrier to implementation.
- Research sustainability training in airports—internal versus external training and opportunities for external training for employees.
- Research incentives for sustainability and the success of certain practices, including analysis of incentive types and delivery methods.
- Survey the 12 stakeholders/user groups on their perceptions of sustainability at airports and compare with the airports' perceptions.
- Explore opportunities for airlines and airports to form joint interactions that promote sustainability.
- Provide incentives for tenants and customers for sustainability practices at airports.
- Determine how airports are implementing life-cycle costing for sustainability practices; identify savings/ avoided costs and cost-effectiveness (or individual sustainability practices).

ACRP conducted four different studies on sustainability that build on and address several of the above recommendations.

## 4.7 ACRP Report 80: Guidebook for Incorporating Sustainability into Traditional Airport Projects (2012)

### 4.7.1 Overview

*ACRP Report 80 Guidebook for Incorporating Sustainability into Traditional Airport Projects* is the second in a series of five studies ACRP has conducted on sustainability to date. Report 80 “describes sustainability, its benefits, and identifies different applications in traditional airport construction and everyday maintenance projects. An accompanying CD-ROM provides an Airport Sustainability Assessment Tool (ASAT) that complements the guidebook and can be used to: assist the user in identifying sustainability initiatives that might be most applicable to an airport project, given certain criteria that the user sets; obtain more information about specific strategies; and learn about sustainability initiatives that have been implemented at other airports through case studies.”

### 4.7.2 Review

The Guidebook was developed as a follow-on to ACRP Synthesis Report 10, and is an easy to use resource that contains several real-world and practical illustrative examples of how other agencies (not just airports) have incorporated sustainability into their projects. For example, when it discusses water efficiency it explains how Pacific Northwest National Laboratory (PNNL) reduced their irrigation costs by 30% across their 600 acre campus with 2 million square feet of facilities. Though this is not an airport, it is easy for the reader to grasp the comparison as airports usually cover very large areas, have multiple buildings and have the same challenges keeping their external landscapes pristine while conserving water. Examples, related to terminals covered include but are not limited to Green roofing, energy efficient lighting, double-glazed windows, Green products, and little but important steps such as double-sided printing settings for copiers and printers. The accompanying Airport Sustainability Assessment Tool (ASAT) guides the user through the basic framework of a sustainability decision-making process along three different tracks:

- **Track 1:** designed for those who are already considering implementation of a particular sustainability strategy and want to know more about it;
- **Track 2:** designed for those who are searching for ideas of sustainability strategies for potential implementation at their airport; and
- **Track 3:** designed for those who are interested in learning what sustainability initiatives other airports have implemented. the more on be m

The report is process based and is more useful in an operational setting than for development of say a new terminal.

### 4.7.3 Gaps and Recommendations

The Report is well written and easy to read, and is a very useful go-to resource airport operators can use to both develop their sustainability related programs, or just keep as a handy go-to reference. No significant gap was identified and hence no recommendations for this study.

## 4.8 ACRP Report 110: Evaluating Impacts of Sustainability Practices on Airport Operations and Maintenance (2014)

### 4.8.1 Overview

*ACRP Report 110: Evaluating Impacts of Sustainability Practices on Airport Operations and Maintenance* provides an evaluation process and cost–benefit tool to evaluate lifecycle costs of sustainability practices being considered by airport operators. Many airports are implementing practices that are considered to be sustainable, i.e., they have environmental, social, and/or economic benefits. Airports implement sustainable practices because of local and regional priorities, or because the implementation costs may have appeared to be relatively inexpensive without long-term implications being considered. A lifecycle analysis looks at not only the capital costs and retiring costs but also the ongoing maintenance costs. The evaluation process and the cost–benefit analysis tool on this project were developed to evaluate such practices, techniques, methods, or equipment. An accompanying User’s Guide provides a step-by-step review of the tool and includes an information sheet identifying the relevant data needed to evaluate the practices. Airport environmental, operations, maintenance, and executive staff in evaluating the costs and benefits between existing and proposed practices should find the tool useful.

### 4.8.2 Review

The focus of the study was development of the cost-benefit analysis tool to assist operations and maintenance (O&M) staff capture the life-cycle costs and benefits of projects. The evaluation process developed was meant to serve as an aid to engage the O&M staff early in the decision making process of sustainability initiatives. The Report 110 project team was tasked to address the following five sustainability categories:

- Water conservation
- Energy conservation
- Waste management
- Consumables and materials (e.g., paper products, paints, light bulbs, filters)
- Alternative fuels

Hence, the tool developed during the project covers those five categories. The tool itself has five steps that involve:

- Identifying the sustainability practice: selecting a sustainability practice from the five above, and entering basic information about the project, baseline costs and lifecycle costs. Baseline costs are defined as costs that currently are or are expected to be incurred at the airport but will not be incurred if replaced by the new sustainability practice.
- Start-costs which include upfront costs associated with construction, equipment, training, legal requirements and compliance, and switching out old equipment for new equipment are entered for both options.
- Operations and maintenance cost for both options.
- End of life costs (salvage value).
- Finally users enter the performance and qualitative impacts. This is to identify impacts to customer experience, safety and health of customers and employees, recognition as a leader of environmental management and practice, procedural impacts, and other aspects that are not considered as part of the lifecycle costs. It includes all relevant impacts that were not captured during the Startup, Operations & Maintenance, and End of Life cost.

Below is a schematic of steps in the tool.



The Output from the tool provides “key metrics specifying the monetary impacts of the sustainability practice are presented, both in numerical and graphical form. The user is able to view cost impacts both at an aggregate and individual cost level. The qualitative impacts identified in the Inputs section are represented in a manner that highlights the most significant impacts to the airport.”<sup>vi</sup>

#### 4.8.3 Gaps and Recommendations

No critical gap was identified for the study but we will recommend that ACRP conduct a survey of users of the tool developed. The survey can focus on interviewing selected airports that have used the tool, and documents benefits and any challenges they faced in using the tool. We recommend ACRP use *Impacts on Practice* report rather than a Synthesis or ACRP Report to document and disseminate the findings.

## 4.9 ACRP Report 119: Prototype Airport Sustainability Rating System Characteristics, Viability, and Implementation Options (2014)

### 4.9.1 Overview

*ACRP Report 119: Prototype Airport Sustainability Rating System—Characteristics, Viability, and Implementation Options* identifies the features of a sustainability rating system specifically developed for airports, identifies options for implementing the rating system and a certification program, and evaluates the viability of their implementation and adoption. The report provides a framework upon which a comprehensive airport-centric rating system can be built should the airport industry decide it would be beneficial for assessing its sustainability performance.<sup>vii</sup>

### 4.9.2 Review

The design specification of the Prototype Rating System was built around the five points below:

1. Incorporate elements of existing rating systems to the extent possible.
2. Include a points-based scoring framework.
3. Adhere to the EONS (**E**conomic Performance, **O**perational Efficiency, **N**atural Resource Conservation, and **S**ocial Responsibility) sustainability framework.
4. Recognize airport-wide sustainability performance (as opposed to individual focus on airport projects).
5. Emphasize flexibility to accommodate all airport types.

The EONS framework adopted is similar to the three key areas of economic (E), social (S), and environmental (N), with Operational Efficiency as an additional area. The rating system developed had 50 sustainability activities, grouped into the 8 sustainability categories:

1. Energy & Climate
2. Engagement & Leadership
3. Water & Waste
4. Natural Resources
5. Human Well-being
6. Transportation
7. Economic Performance, and
8. Design and Materials

A **scoring framework** supports the rating system by providing a mechanism for establishing a rating (see Figure S-4). The basic construct of the scoring framework is simple: airports score points for achieving levels of performance within each sustainability activity. Points can be earned and summed for all sustainability activities to gauge airport-wide performance across the entire Prototype Rating System, within each category to gauge performance in sectors such as energy and climate or human well-being, or for a single sustainability activity to target performance in one area. This framework can be used to evaluate internal sustainability performance and scaled to accommodate more robust certification and verification or optional external comparisons over time.

Energy & Climate		Engagement & Leadership	
EC 1	Terminal Building Energy Use	EL 1	Airport-Wide Stakeholder Engagement
EC 2	Overall Airport Energy Use	EL 2	Public Outreach
EC 3	Renewable Energy Use	EL 3	Community Stewardship
EC 4	Terminal Building GHG Emission Reductions	EL 4	Integrated Sustainability Management
EC 5	Overall Airport GHG Emission Reductions	EL 5	Airport User Engagement & Outreach
EC 6	Other Indirect GHG Emission Reductions	EL 6	Tenant & Vendor Sustainability
EC 7	Climate Change Adaptation		
Transportation		Water & Waste	
TR 1	Fleet Vehicle Fuel Economy	WW 1	Potable Water Conservation
TR 2	Airside Equipment Fuel Use	WW 2	Waste Reduction
TR 3	Alternative Vehicle Fuels	WW 3	Waste Diversion
TR 4	Alternative Passenger Transportation		
TR 5	Alternative Employee Commute		
Economic Performance		Natural Resources	
EP 1	Socially Responsible Financial Investments	NR 1	Landscape & Grounds
EP 2	Airport Financial Viability	NR 2	Wildlife & Habitat Protection
EP 3	Risk Management	NR 3	Pervious Surface
EP 4	Regional Economic Contributions	NR 4	Airside Stormwater Quality
		NR 5	Wildlife Hazard Management
		NR 6	Heat Island Reduction
Design & Materials		Human Well-being	
DM 1	Sustainable Design & Operation	HW 1	Airport Noise Compatibility
DM 2	Material Selection	HW 2	Workplace Air Quality
DM 3	Construction Waste Diversion	HW 3	Light Pollution
DM 4	Construction Impacts Mitigation	HW 4	Chemicals & Hazardous Materials
DM 5	Sustainable Site Selection	HW 5	Passenger Experience
DM 6	Local Sourcing	HW 6	Employee Development
DM 7	Recycled & Bio-based Content	HW 7	Labor Relations
DM 8	Low-Toxicity Materials	HW 8	Diversity & Equal Opportunity
DM 9	Environmentally Preferable Purchasing	HW 9	Occupational Health & Safety
		HW 10	Universal Design

From ACRP Report 119 Figure S-1 *Prototype sustainability categories (8 categories) and sustainability activities (50 activities).*

#### 4.9.3 Gaps and Recommendations

The report states that the development plan ACRP conceptualized for the project (ACRP Project 02-28) involves future phases that are dependent on whether the airport community believes it is appropriate to move forward with preparing a full Draft Rating System. A summary of the work phases are:

- **Phase I and Phase II (Prototype Rating System Development).** These phases involved preparing draft and final versions of the Prototype Rating System. These phases are now complete (Report 119).

- **Phase III (Draft Rating System and Pilot).** This potential phase would consist of preparing a functional Draft Rating System that would include a draft User Guide and scoring framework and would assign draft points to each of the activities. At the conclusion of Phase III, the rating system could be piloted at a select set of airports.
- **Phase IV (Finalize Rating System and Release).** Once the lessons learned from the pilots in Phase III were captured, the Draft Rating System could be revised into a fully formed, final airport sustainability rating system. Finalizing the rating system would likely require revising the scope of some activities, perhaps adding activities that were identified through the pilot, and likely recalibrating weighted point scores assigned to each activity, based on feedback from the rating system pilot. The development costs associated with finalizing the rating system would vary depending on the scope of the final product, but would likely be within a range of approximately \$500,000 to \$2 million—though they could rise to as much as \$5 million if the final product were coupled with an advanced independent certification and verification program. Once complete, the rating system would require a hosting organization that would be responsible for ongoing maintenance of the system.

Given that the rating system is very detailed and extensive in its current form, the key gap we identify is a need for ACRP to investigate the level of adoption and use by practitioners of the prototype now before embarking on Phase III. The report was released in 2014, so ACRP may want to plan to conduct such a survey late 2016 or in 2017. The survey should interview selected airports that have used the prototype rating system, and document benefits and any challenges they faced in implementing the rating system. We recommend an *Impact on Practice* instead of a Synthesis or ACRP Report to document the findings.

#### 4.10 ACRP Synthesis Report 66: Lessons Learned from Airport Sustainability Plans (2015)

##### 4.10.1 Overview

The goal of *ACRP Synthesis Report 66 Lessons Learned from Airport Sustainability Plans* was to focus on smaller airports to identify their experiences and challenges they might be facing implementing sustainability initiatives. The scope of this synthesis included:

- Review of existing airport sustainability planning documents, with an emphasis on non-hub commercial service and general aviation (GA) airports, to determine definitions of sustainability, initiatives included, major focus areas, and scope of the planning documents.
- Interviews that examine delivery on commitments outlined in the plans, long-term program management, barriers and aids to implementation, and whether comprehensive airport sustainability plans are more beneficial than is implementing projects on an ad-hoc basis. Interview results are presented as case examples and lessons learned in summary format.
- Identification of costs or benefits realized from the existence (or absence) of an airport sustainability plan.

##### 4.10.2 Review

The study found that many smaller airport respondents are in the early stages of implementing sustainability plans. Lack of available financial and staff resources is cited most often as the reason for delayed sustainability performance improvements. Nearly all of the respondent airports are reducing energy consumption, and initiatives related to energy reduction are often financed by outside parties and implemented independently of a formal sustainability plan. Airport survey participants viewed sustainability programs as costly to design.

The survey found certain consistencies among the respondent airports. Sustainability initiatives adopted by smaller airports, regardless of the existence of a formal sustainability plan, included the following:

- Lighting upgrades, including LED lights
- Solar and geothermal energy systems
- Recycling of municipal and construction waste
- Planting trees and native plants
- Community and stakeholder outreach
- Employee programs
- Funding from nontraditional sources.

The top five drivers, aids and barriers for sustainability initiatives are listed in table below. Comparing the findings with the first ACRP Synthesis it is obvious cost is a big challenge for smaller airports, but the high rank of community relations a driver indicates smaller airports may be more engaged with their communities, which is to be expected given their size.

The top 5 sustainably drivers at smaller airports (ACRP Synthesis 66)

Top 5 Drivers	Top 5 Aids Top	5 Barriers
Cost reductions	FAA and other funding	High cost; lack of funding
FAA funding availability	Management support	Limited staff availability
Management support	Tools for tracking resource use and cost/benefit	Lack of operational control
Community relations	Stakeholder support	Lack of data on resource use
Environmental compliance	ACRP publications	Entrenched culture.

Top 5 sustainably drivers from ACRP Synthesis 10 Airport Sustainability Practices

Rank	Current (in 2008)	Future
1	State/Regional Regulations	Stakeholder Concerns/ Relations
2	Airport Policy	Global Trends
3	Federal Regulations	Airport Policy
4	Corporate Responsibility	Corporate Responsibility
5	Stakeholder Concerns/ Relations	Federal Regulations

#### 4.10.3 Gaps and Recommendations

The report identified the following areas of interest that could benefit from further research:

1. Smaller airports are in the early stages of adopting sustainability initiatives, but information on measurable outcomes was not available. Thus, additional research on quantifying cost reductions and other benefits from initiatives, such as recycling pavement and metals, would be helpful to these airports.
2. The process of implementing initiatives after identifying them is also a fertile area for research.
3. In addition, the link between sustainability programs and non-environmental components such as economic viability (growing the business) and social responsibility (community and human factors) could be explored in a subsequent research project.
4. Finally, smaller airports would benefit from a description and analysis of tools that can be used for tracking sustainability metrics and performance.

Most of the points identified above are being addressed in other ACRP sustainability projects. ACRP Report 110 covers the process for evaluating lifecycle costs, ACRP Report 80: Guidebook for Incorporating Sustainability into Traditional Airport Projects is a good starting point to understand the process of implementing initiatives. ACRP Report 119: Prototype Airport Sustainability Rating System Characteristics, Viability, and Implementation Options and ACRP Report 110 Evaluating Impacts of Sustainability Practices on Airport Operations and Maintenance provide some of the tools for tracking sustainability metrics and performance.

#### 4.10.1 Gaps and Recommendations

No major recommendation for this study.

## 4.11 ACRP Synthesis Report 51: Impacts of Aging Travelers on Airports (2014)

### 4.11.1 Overview

The number of aging and elderly travelers is increasing, challenging airports and airlines to respond to the physical and psychological needs of this important demographic. According to the Administration on Aging, the number of persons over 65 years of age is projected to increase from 40 million in 2010 to 70 million—from 13% to 19% of the population—by 2030. Although healthier in some respects than earlier generations, this age group is subject to such chronic illnesses as cardiovascular disease, Alzheimer's, diabetes, osteoporosis, and obesity, any of which can affect a person's ability to navigate an airport.

### 4.11.2 Review

The normal effects of aging, including muscular/skeletal problems, respiratory conditions, and deteriorating sight and hearing, also play a role. Contributing psychological issues include anxiety and lack of ability to adapt to change. The stress affecting anyone undertaking a major journey can be felt more acutely by an older person because of the factors mentioned above. This study identified the following as the most prevalent issues the elderly face:

- Wayfinding:
  - Unfamiliarity with a complex airport environment
  - Unclear or confusing informational and directional signage
  - Difficulty understanding the meaning and terminology of directional signs.
- Fatigue:
  - Standing or waiting in line, at check-in, passenger security screening, bag claim, or curbside
  - Long walking distances in the terminal, parking garage, and surface lots
  - Handling heavy bags at curbside, check-in, and bag claim.
- Technology and equipment:
  - Understanding and using self-service devices
  - Negotiating the security checkpoint process
  - Using escalators and moving walkways.
- Amenities:
  - Difficulty in using toilet facilities
  - Using congested retail and food service concessions.

A broad understanding of the current impact of aging travelers on airports, and what is being done to accommodate them, was established through an Internet review of relevant literature and a two-part survey of knowledgeable airport representatives in the United States and Canada. Fifteen of 18 airports selected for interviews responded to questions (an 83% response rate) each, providing important contributions to the study process.

The conclusion of the study was that airport operators are aware of the needs of the elderly and are working to accommodate them. The key challenges airport operators face are lack of a well-coordinated policy, the constraints presented by existing buildings, and the costs of implementation both in terms of capital investment and increased staffing. The report will be of special interest to airport operators, airlines, and related stakeholders in understanding the aging demographic, defining issues, and implementing effective practices to accommodate aging travelers.

#### 4.11.3 Gaps and Recommendations

This report was not ranked as high during Task 1, but it is included because the team (ACRP 07-15) has identified it as an emerging need that could become critical in the next few years as ‘baby boomers’ age.

The report authors identify the following topics for further research:

- Research on the development of overall goals and objectives for accommodating the aging and elderly traveler, perhaps as a precursor to creating policy guidelines for the industry
- Investigating the concept of “elder tags” for checked baggage that would identify bags whose owners might need assistance in the bag claim hall
- Identifying the opportunities and challenges of “compact transit,” whereby motorized carts are used not as an ad hoc back-up system for moving people but as a recognized and designated means of movement through the terminal for elderly and disabled passengers
- Further examination of smart phone applications available and being developed that would help the elderly in trip planning, wayfinding, and other travel issues
- A survey of aging and elderly travelers to identify the issues they faced along their journey so that the published issues can be validated and expanded
- Research on collaborative approaches between airports, airlines, and/or other stakeholders to better serve aging travelers and meet or exceed the requirements of the Air Carriers Access Act
- Research into the design of future accommodations for aging travelers at airports
- Research into the cost/benefits of catering to the needs of the aging traveler.

This is a topic that requires some additional review beyond the report. Our plan is to review airport terminal design guidelines (FAA & IATA) and evaluate the guidance (if any) these documents provide on accommodating the elderly in terminal buildings. We will identify and contact subject matter experts at these agencies and in the industry to understand what is being done in the short term to accommodate this growing population. Based on the findings from our review we will make a determination if to develop a problem statement for this topic.

## 4.12 ACRP Report 130: Guidebook for Airport Terminal Restroom Planning and Design (2015)

### 4.12.1 Overview

The guidebook provides step by step guide of planning, design and implementation of terminal restroom projects. It provides information about all aspects of restroom design, operations and maintenance for airport consultants.

### 4.12.2 Review

This guidebook is very recent and covers all major aspects of Restroom planning for today's airports. Some additional information about following topics can augment the information covered in the report

1. **Shower facility:** Information about shower facilities can be added as a part of restroom layout. Airports with considerable traffic of international business travelers or with early group check-in (e.g. MCO, FLL, MIA, LAS) can have these facilities for a quick shower before or after long journey.
2. **Spreadsheet models:** Similar to ACRP Report 25 volume 2, a spreadsheet model can be generated based on the numbers given in the reports to calculate areas and number of fixtures and toilet accessories required, based on LOS. A comparative calculations based on International Plumbing Codes (latest edition) can be generated to give an idea about the difference between the two. A note about verifying the applicable code numbers can be added.
3. **Hypothetical Illustrative Examples:** Based on the information about planning information discussed in the report, a hypothetical example can be added as an appendix. it can be an example of real case without naming the airport. The example will make the report more practical for readers.
4. **Ablution facility:** Ablution (cleaning of body parts) is a ritual in some religions (common practice in Islamic states). Many airports in US are providing these areas as a part of restroom. General information and unit area calculations can be added for planning purposes.
5. **Nursing/Family restroom considerations:** Lactation area can be added in women restrooms with a chair and curtain.
6. **Shelving:** Under the spatial component, in urinal area, a language about having a shelf behind the urinal can be added. This is increasingly becoming a desired amenity. The shelf is useful to store small handheld items for a short time.

### 4.12.3 Gaps and Recommendations

Report needs to be selectively revised/updated to include additional information identified above. Depending on decision ACRP makes on Report 25, information from this report could feed into future updates of ACRP Report 25.

#### 4.13 ACRP Report 55 Passenger Level of Service and Spatial Planning for Airport Terminals (2011)

##### 4.13.1 Overview

*ACRP Report 55 Passenger Level of Service and Spatial Planning for Airport Terminals* was developed as a comprehensive resource to address the Passenger Level of Service and Spatial Planning for Airport Terminals. The objectives of this Guidebook were: “a) to develop standard space allowances for passengers in each area of the airport terminal, b) to identify an appropriate level-of-service (LOS) framework, c) and to identify a dynamic or holistic measure representing a passenger’s overall experience of the journey.” The guidance provided in this document complements the traditional Level of Service framework used by airport stakeholders and developed by the International Airline Transport Association (IATA). The IATA LOS framework is based on the work done by John Fruin and documented in the Highway Capacity Manual.

##### 4.13.2 Review

The analysis documented in the report included a data collection study employing qualitative and quantitative measures to relate level of service and space allocated to various airport terminal spaces. The analysis also included ethnographic interviews and *in-situ* observations at seven airports. The team used the results of the surveys to derive passenger space guidelines that were associated with favorable passenger perceptions of airport terminal LOS. The data produced intriguing results that *suggest more research may be needed* to understand ethnographic factors that would help airport designers establish better correlation between spaces offered, quality of the space and perceived level of service. The study presented does not change the IATA guidelines in terms of levels of service used in planning and design (LOS C). However, the recommendation is to use design level of service C provided the space is based at the end of the planning horizon.

The following are key findings of the report:

- The generally accepted assumption of a high correlation between higher perceived LOS and lower density in airport spaces was not found,
- A positive correlation between passenger perception and lower wait times was found in the surveys. This was true in security screening checkpoints, baggage claim areas and both agent-manned and kiosk check-in areas,
- There were no statistical differences in perceived level of service between business and leisure travelers,
- There were no statistical differences in perceived level of service for various air carriers
- Passenger’s perception of higher level of service seem to be associated with lower waiting times, and
- The quality of space in the airport terminal as it relates to the passenger needs seems to be an important space-related parameter for good perceived level of service.

##### 4.13.3 Gaps and Recommendations

Chapter 4 of the document provides conclusion and recommendations for further research. Considering the scope of this report and the number of topics covered, we have identified the following gaps that could be developed into future ACRP problem statements. Below are topics that may require further research and can improve the scope and value of ACRP Report 55.

1. Research on best practices of using ethnographic data collection techniques to understand passenger perceptions inside an airport terminal.
2. While the authors' do not advocate more traditional LOS passenger surveys, they advocate more "ethnographic" surveys to understand how perceived level of service is affected by factors that contribute to a reduction of passenger stress (i.e., wayfinding, control of journey time, short walk distances or quick travel times, reliable flight status information, etc.)
3. New data collection survey techniques should be studied to expedite passenger response rates and to track passengers around the terminal. The authors recognize that new mobile technologies such as GPS and Blue Tooth could be used to collect better data at airports. According to the study. TSA and some airports collect passenger wait times at processors using mobile technology.

#### 4.14 ACRP Report 37 Guidebook for Planning and Operations of Automated People Mover Systems at Airports (2010)

##### 4.14.1 Overview

ACRP Report 37 was developed as a comprehensive Guidebook for Planning and Operations of Automated People Mover Systems at Airports. The objectives of this Guidebook are: a) to provide comprehensive information on the planning and implementation of APM systems, b) to provide details on various APM systems. The guidebook information is relevant to a wide audience. This includes, airport designers, airport contracts staff, airport operations and maintenance personnel and even the flying public. The report is organized in twelve chapters.

##### 4.14.2 Review

While the development of APM system traces its roots to urban applications, these complex systems have been adapted to airports successfully. The authors point out 44 APM applications to date. APMs have primarily been implemented at major airports around the world. The ACRP document contains a CD with detailed characteristics of 44 worldwide APM systems in place. The following are key findings of the report:

- APM systems offer ease of boarding and capacity flexibility to airports,
- APM systems are partially responsible for the success of large “hub” airports by allowing longer distances between airport terminal facilities while maintaining acceptable walking distances for passengers,
- APM have reduced airport access road congestion and local emissions

The report provides some topics for future research:

- Power and energy consumption requirements of APM systems and sustainable planning practices, and
- Planning and design practices on new mobile conveyance technology associated with Personal Rapid Transit systems.

##### 4.14.3 Gaps and Recommendations

In our view, both topics are relevant in the planning and operation of APM systems. However, we do not believe they warrant immediate research efforts by ACRP because both topics very narrow in scope. The second topic has very few applications worldwide with limited information on true PRT technology. PRT technology has been proposed for 50 years and yet, today, only three true PRT systems have been implemented worldwide.

#### 4.15 ACRP Report 37A Guidebook for Measuring Performance of Automated People Mover Systems at Airports (2012)

##### 4.15.1 Overview

ACRP Report 37A was developed as a comprehensive Guidebook for Measuring Performance of Automated People Mover Systems at Airports. The objectives of this Guidebook are: a) to provide airport operators with performance measures and data requirements to benchmark the performance of APM systems and, b) to define APM system and service descriptive characteristics associated with APM performance measures. The guidebook information is relevant to airport operators. The report is organized in seven chapters.

##### 4.15.2 Review

The report identifies seven APM performance measures addressed in various sections of the report. Similarly, the report found six important system characteristics and five service characteristics of APM systems to report. In this context, the report is very comprehensive considering the limited number of measures and characteristics that describe an APM. The report provides three forms that can be used by airport operators to measure APM system performance, to collect system and service descriptive characteristics and to collect passenger satisfaction information. These forms are provided in Microsoft Excel format.

##### 4.15.3 Gaps and Recommendations

Based on our review of our review of the ACRP report 37A Guidebook for Measuring Performance of Automated People Mover Systems at Airports, we do not believe there are many relevant gaps that require immediate research efforts by ACRP.

#### 4.16 ACRP Report 41: Guide to the Decision Making Tool for Evaluating Passenger Self Tagging (2011)

##### 4.16.1 Overview

The Report provides the information and tools, necessary for an airport or airline to determine the appropriateness of pursuing passenger self-tagging should it be allowed in the United States in the future. The decision-making tools provide both qualitative and quantitative information that can then be used to assess if passenger self-tagging meets organizational needs or fits into their strategic plan.

##### 4.16.2 Review

The guidebook helps to make the decision about method of baggage tagging. It provides tools to analyze existing airport and make evaluate ease of implementation. Considering that this not a common practice in US yet and not many airports implemented it, there are no research gaps, at this point, from terminal planning perspective.

##### 4.16.3 Gaps and Recommendations

Some US airports are seriously consider implementing this practice more widely, and the relevance of this subject matter may accelerate substantially. We identified this gap during review of Report 10, and the problem statement selected is complementary to this report.

#### 4.17 ACRP Report 117: Airport Escalators and Moving Walkways Cost Savings and Energy Reduction Technologies (2014)

##### 4.17.1 Overview

This guidebook provides a systematic approach to identifying, evaluating, and selecting cost saving and energy reduction technologies that can be applied to airport escalators and moving walkways. The accompanying financial tool calculator can be used to help airports reduce energy consumption and operational costs, improve reliability and customer service, and meet environmental stewardship goals.

##### 4.17.2 Review

The guidebook talks about technical and technological aspects of elevator and escalators and how they can be used to optimized the energy consumption. The report can be a useful reference for airport planner/ designer to select these equipment. However, it does not discusses any planning aspects of elevator or escalator. Hence, there are no research gaps from terminal space planning perspective.

##### 4.17.3 Gaps and Recommendations

No immediate need to revise or update this report.

4.18 ACRP Report 61: Elimination or Reduction of Baggage recheck for arriving international passengers (2012)

4.18.1 Overview

The report discusses alternatives for existing practice of rechecking the international baggage at port of entry in US that will increase the efficiency. It argues about the benefits and issues of implementing them at domestic airports.

According to preface, the Report (1) identifies potential alternative procedures that could be implemented to reduce or eliminate the need for the recheck of baggage for arriving international passengers at U.S. airports; (2) describes in detail the benefits and costs associated with these alternative procedures to airports, airlines, and federal agencies; and (3) compares potential alternative procedures with current practices.

4.18.2 Review

The report discusses Existing process of baggage recheck by Customs and Border Protection (CBP) at “Port of Entry” airports in US. It explains need for rechecking, describe current practices and need for alternatives to optimize the flight connection time for passengers. The report also explains the difference between reducing the need for rechecking the bags and totally eliminating the procedure. However, at this point, it advocates more for reduction than total elimination.

With the help of case studies of some large hub airports in US, the report explains current flow of international passenger and baggage arrivals, further domestic and international connections and potential advantages of proposed alternative solutions in increasing efficiency.

The report discusses different procedures that are currently in place on some airports in the country with varying degrees of success. It examines the process and flow of checked baggage on arrival in each procedure and its pros and cons for all the stakeholders/ agencies involved. Following procedures were evaluated based on the way baggage will be screened by CBP before either transferring to connecting flight or delivering it to terminating passengers.

Procedure	Description
<b>Exception of checked baggage from FIS</b>	Baggage will be transferred directly to TSA and to onwards journey avoiding the CBP check
<b>New airline/ Airport processes on arrival</b>	In addition to direct transfer, airlines or airport provide additional information like baggage scan, image to TSA
<b>New CBP processes on arrival</b>	In addition to direct transfer, CBP provides additional support while baggage is offloaded in order to expedite the transfer and avoid recheck
<b>Enhanced pre departure procedure</b>	Information about baggage is given to CBP at the time of departure.
<b>Information sharing with TSA programs</b>	TSA and CBP share information, X-ray images and algorithms. CBP office can be present in TSA screening area.
<b>Leveraging other DHS programs</b>	Uses other DHS programs like Global Entry to screen the baggage
<b>Door to Door baggage service</b>	Transfer the baggage separate from passenger. screen check baggage as cargo and deliver it to the destination address in US

The reports presents a range of possible alternatives to existing practices that can adopted by some airports. It also evaluates the challenges and constrains in implementing the alternatives.

#### 4.18.3 Gaps and Recommendations

Report is a good reference for planners and designers in understanding future trends while designing current CBP area. Given the report was published in 2012 and immediate update is not needed, but ACRP should plan for periodic updates (every five years) as TSA guidelines and CBP regulations tend to change and evolve over time.

#### 4.19 ACRP Report 54: Resource Manual for Airport in Terminal Concessions (2011)

##### 4.19.1 Overview

*ACRP Report 54: Resource Manual for Airport in Terminal Concessions* provides guidance on the development and implementation of airport concession programs. The report provides information on the airport concession process; concession goals; potential customers; developing a concession space plan and concession mix; the Airport Concessions Disadvantaged Business Enterprise (ACDBE) program; and concession procurement, contracting, and management practices.

##### 4.19.2 Review

The guidebook covers all aspects of concessions space planning and design in terminal. It mentions all the conventional concessions programs and their requirements. However, there are some unconventional concessions that are coming up mainly on international airports. These include areas for special events, live music performances, cinema (especially at airports where early group check-ins are high), fresh fruit and vegetable market at arrival sides, departmental stores.

##### 4.19.3 Gaps and Recommendations

There can be an additional research done (as a Synthesis report) to explore feasibility and spatial requirements of such unconventional concessions at US airports in the future. For the purposes of this study (ACRP 07-15) we do not think this is a high priority task that ACRP should commit resources to at this time.

## 4.20 ACRP Report 96: Apron Planning and Design Guidebook (2013)

### 4.20.1 Overview

This Guidebook provides Best Practices for the planning, design and marking of apron areas for all types of airports in the United States. It also, incorporates aspects such as flexibility in design and operational safety of aircrafts. According to the Report preface, the apron planning and design considerations include facility geometrics, aircraft maneuvering, apron/airfield access points, operational characteristics, markings, lighting, and aircraft fleets. In addition, the types of aprons include terminal area, deicing, general aviation, cargo, maintenance, and remote aprons and helipads. The guidebook summarizes apron planning and design best practices for incorporating flexibility, increasing efficiency, and enhancing safety of apron facilities.

### 4.20.2 Review

The Guidebook, reviews apron planning and explains in detail the way apron areas function, different types of vehicular movements that happen in apron areas, and how to plan for them. The Guidebook also explains different government regulatory agencies (FAA, TSA, etc.) involved in the planning process. The guidebook discusses the following points that are good references to consider during airport terminal design and planning.

Scope	Description
<b>Passenger enplaning and deplaning</b>	Passenger Loading Bridges, Ground loading, Remote loading
<b>Terminal building layout</b>	linear, Wrap around, Inside Wrap, floor height of hold rooms, gate configuration
<b>Planning and designing of Apron</b>	Different software used for planning, pavement, lighting

### 4.20.3 Gaps and Recommendations

This Guidebook is a good reference for planners and designers of airports, but the focus is on design of the aprons and not the airport terminal building. No additional research is needed for this topic at this time.

## 4.21 ACRP Report 52: Wayfinding and Signing Guidelines for Airport Terminals and Landside (2011)

### 4.21.1 Overview

*ACRP Report 52: Wayfinding and Signing Guidelines for Airport Terminals and Landside* provides an up-to-date single resource for airport operators to consult as they review, update, enhance, or develop their airport wayfinding and signing plan. The guidelines focus on four areas of the airport: (1) roadways—both on-airport, and off-airport access roads; (2) parking; (3) curbside and ground transportation; and (4) terminal. In addition, the guidelines discuss developing a wayfinding strategy; the use of technology and visual displays; and color, fonts, and sizes. These guidelines are a handy resource for airport planners, consultants, and those specifically responsible for maintaining an airport wayfinding and signing plan and signage.

### 4.21.2 Review

The report is a very extensive study and covers a wide range of topics related to wayfinding including the terminal roadways and parking. Chapter 6 is a very detailed covering of wayfinding and signage within the terminal building, and addresses basic principles, human factors, sign categories, design elements, appropriate location of signs, illumination, materials, safety, sign maintenance and accessibility. The content of the report is very useful to both those who plan and design the airport (consultants, especially architects) and operators (managers, and O&M staff).

#### 4.21.1 Gaps and Recommendations

This is a very comprehensive guide but much of the content is very relevant to ACRP Report 25 Airport Passenger Terminal Planning and Design. ACRP should consider dedicating a chapter for this topic in ACRP Report 25 the next time that Report 25 is updated.

## 4.22 ACRP Report 109: Improving Terminal Design to Increase Revenue Generation Related to Customer Satisfaction (2014)

### 4.22.1 Overview

*ACRP Report 109: Improving Terminal Design to Increase Revenue Generation Related to Customer Satisfaction* is a handbook of global best practices for airport management and industry professionals. It will inform airport practitioners of innovative airport planning and terminal design and will promote profitable revenue generation and customer satisfaction at a variety of airport sizes and types. The handbook includes consideration of how to facilitate innovation in improving the customer experience through the use of technology and other resources.<sup>viii</sup>

### 4.22.2 Review

The study explore three areas, terminal concessions, airport customers, and ancillary land development that airport managers and operators could explore to generate additional revenue. Of the three, land development is related but not directly related to the scope of this study. The study explore how terminal configuration and layout could either improve or hamper level of utilization of concessions. The evaluation was based on extensive data collection. The general finding was that design and configuring terminals so that passenger flow is concentrated increases the potential of traffic and hence revenue generation from concessions. However, concentrating the flow of passengers is not enough, the right kind and mix of concessions has to be targeted to the needs to the type/kind of passenger. Some general rules of thumb were:

- Allocate approximately one-half of the total concession space to food and beverage concessions. Then distribute the remaining space to specialty retail, duty-free retail, and convenience retail, with at least half of the total retail space allocated to specialty retail.
- Allocate at least one-half of the total food and beverage service space to quick-service concepts.
- Allocate the largest amount of food and beverage service space to casual dining and quick-service concessions.
- A large portion of the food and beverage service concessions should be nationally branded.
- A large portion of the specialty retail concessions should be nationally branded.
- When determining brand diversity, consider variety both within the airport concession program and at other airports. Brands that already saturate the airport market may not perform as well and potentially detract from the freshness of a program.

There also the need to create passenger awareness of concession offerings by targeted placement, clear and concise signage, and maps of the terminal area.

### 4.22.3 Gaps and Recommendations

The document is very well written and no critical gaps were identified. No immediate need for updates to this publication at this time.

## 4.23 ACRP Report 40: Airport Curbside and Terminal Area Roadway Operations (2010)

### 4.23.1 Overview

This guide presents a cohesive approach to analyzing traffic operations on airport curbside and terminal area roadways. The guide describes operational performance measures and reviews methods of estimating those performance measures. A quick analysis tool for curbside operations and low-speed roadway weaving areas is packaged with this guide. Techniques for estimating traffic volumes are presented as well as common ways of addressing operational problems. The guide should be useful to airport landside operators, transportation planners, and consultants analyzing airport curbside and terminal area roadway operations.<sup>ix</sup>

### 4.23.2 Review

Roadways in general tend to be designed and operated by agencies that are unfamiliar with the airport operating environment and issue and challenges travelers face as they try and navigate their way to and from an airport. Airport operators, planners and designers on the other hand are usually challenged when they have to deal with design and management of airport roadways. This report does a good job at bridging that gap, by distilling much of the expertise related to roadway planning, especially weaving analysis, into a format that airport operators and stakeholders can understand and digest. At the same time, it is a useful resource for roadway designers as it explains the unique challenges airport passengers face as they try to navigate their way to catch a flight or leave an airport – usually rushed, apprehensive, unfamiliar with airport environment, and dealing with signage formats that are different from that normally experienced on most roads.

### 4.23.3 Gaps and Recommendations

The section of the report most relevant to terminal design is the Chapter 5 Evaluating Airport Curbside Operations. The software tool developed to estimate airport curbside roadway capacity and level-of-service is based on queuing theory principles. The tool does not need updating but a study to find out how much the airport community is using the tool could be conducted and the results published as an Impact on Practice document.

**5 Appendix B: Draft Problem Statements for Panel Review**

## 5.1 Resource Guide on Airport Baggage Handling Systems (from ACRP Report 25 review)

Baggage handling is key component of airport terminal design planning. Quick and efficient movement of baggage to and from airplane is key for optimizing airport capacity. In today's world, baggage is also a major source of income for many airlines. Post 9/11, the entire process of bag screening went through a sea of changes. The creation of the Transportation Security Administration (TSA) and introduction of in-line screening not only had major impact on planning and designing of these spaces but also affected the way terminal is planned. Most of the US airports, which were built before 9/11, found it challenging to accommodate these changes in existing terminal facilities and went through major planning exercises to expand terminal buildings. Today, BHS are a major and one of the most complex components of an terminal and thorough understanding of its workflow along with understanding of key components of this system is needed for efficient and sustainable deployment and operation.

The objectives of this research are:

To develop a comprehensive resource on Baggage Handling System planning and design aimed at assisting airport planners, manufacturers and airport operators. The report will help planners and architects to design completely new BHS, expansion or modification of existing system along with its operation and maintenance. The report will support existing design criteria including TSA, IATA and FAA amongst others.

Activities to help accomplish this objective should include:

- Review of all related existing ACRP and non-ACRP publications on baggage handling systems.
- Investigate and document new global trends in planning and design of BHS and its impact on existing domestic airports.
- Document workflow of inbound and outbound baggage in a BHS setup.
- Develop graphical information that include critical dimensions for different level of service (LOS) for BHS as per IATA guidelines.
- Document relevant International Building Code (IBC) and ADA requirements for BHS.

## 5.2 Selection and Application of Building Materials for Passenger Terminal (from ACRP Report 25 review)

It is said that an airport is the first and last impression of the geographical location, it is situated in. It often reflects unique sense of local flavor in its design and finishes. Terminal buildings have long life spans, often 50 years or more. All this requires a careful selection and application of building materials, for construction and finishes.

Selection criteria for building materials and its application at airports keep changing over time. Whereas ease of construction and longer spanning capacity became the primary criteria for selecting construction materials; finishes were chosen based on durability, maintenance and ease of replacement. Today, Sustainability and Life cycle Cost Analysis (LCA) also play major role in

selection. Choice of building materials, therefore, can play a major role in terminal's visual appeal and impact, life span of building and its adaptability for future.

The objectives of this research are:

To create comprehensive resource for architects, Interior Designers, engineers and airport operators to help them in selection of these materials for new construction or renovation of existing facilities. The guidebook should also provide guidance to airport operators and designers on how to evaluate life cycle cost implications of selecting different building materials.

Activities to help accomplish this objective should include:

- Identifying difference between structural versus finish materials
- Guidance on evaluating finish materials and their suitability for different applications
- Case studies identifying commonly used structural materials and explanation of their unique characteristics
  - Material selection criteria for Renovation and New construction
  - sustainability aspects and comparative study of Life cycle Cost Analysis
  - Innovations in building materials and future trends with respect to airport terminal design and operation.

### 5.3 Safe Hazardous Waste Material Handling during Airport Construction Projects (from ACRP Report 25 review)

Most of the US airports were built before 1980 when asbestos was acceptable as a building material. Also many terminals were built on brownfield sites with oil spills and potential toxic materials. Renovations and additions to these facilities pose a major challenge to airport operators and contractors, especially with regards to the identification and safe removal of hazardous waste materials during construction.

The Environmental Protection Agency (EPA) has established standard practices related to handling hazardous materials which is followed in US. Many airports in recent past have faced considerable cost escalation and construction delays because of discovery of hazardous waste during construction. The most difficult part of this process is identifying the waste in advance and estimating the cost for its safe removal and disposal.

A Synthesis study on this topic will be beneficial to airport operators, consultant and contractors.

The objectives of this research are to:

- Develop a comprehensive resource on the safe handling and cost effective removal of hazardous waste material during airports projects. The report will examine ways to identify the waste, evaluate its impact on environment, construction cost and schedule. The report will augment existing industry standard guidelines established by EPA.

Activities that can help accomplish this objective should include:

- Review and documentations of existing rules and regulations for removal process from approved agencies like EPA.
- Review of existing procedures followed during construction by contractors

- Chart the workflow and steps for identification and removal
- Prepare and develop approximate cost analysis (or software tools) to assist evaluate impacts on construction schedules.

#### 5.4 Planning and Designing of Low Cost Carrier Terminals (from ACRP Report 25 review)

The success of Southwest Airlines in the domestic US market, has given rise to many airlines who now offer services, based on the low cost carrier (LCC) model. Today, low cost carriers do not only successfully compete with full service (or legacy) carriers but also dominate them in some markets.

A key element of the LCC business model is to keep operating costs as low as possible in order to provide competing low fares compared to the legacy carriers. In order to achieve that, LCC airlines adopt lots of cost cutting strategies like flying aircrafts of same group and passenger class, quick turnaround at gates to maximize aircraft utilization, operating from secondary airports in the region, among other. Due to the growth in LCCs in recent years, some large US airports are considering developing separate LCC terminals to cater their passengers. A Synthesis study to understand the planning and designing needs for these facilities will be beneficial to airport operators and consultants (especially architects and engineers).

The objectives of the study are:

- To develop a guide for Architects, planners and airport operators about planning and designing of new LCC terminal or converting existing in to LCC terminal.
- Supplement existing terminal planning resources and guidelines while identifying key differences between LCC and full service terminal.
- Provide solutions unique to LCC terminals.

Activities that can help accomplish these objectives are:

- Study the requirements of LCC terminal by interviewing operators of airports with dominant LCC traffic, and LCC airlines.
- Study existing international LCC terminals
- Identify difference in planning and designing LCC terminals compared to existing terminals.
- Use the information above to identify and define unique requirements for LCC terminals.
- Prepare comparative analysis of these solutions (between full service and LCC terminals) and approximate cost savings (or implications).

#### 5.5 Integrating Numerical Airport Planning Data and Building Information Modeling (BIM) Tools (from ACRP Report 25 review)

BIM is essentially a digital three dimensional model of a building that contains all the information of its components. This is a very powerful way of analyzing the building for spatial quality, cost, solar study, heat gain and loss and other building systems requirements in advance

that ultimately helps optimizing construction schedule and budget. These Models can also be used for maintenance and automation of building systems.

The spreadsheets in existing ACRP report 25 (Vol.2), compute space related metrics (such as areas, people, length, etc.) that planners and architects then, manually uses in 2 dimensional drawings ( plans, sections etc.) to establish initial spatial relationships and then do mathematical calculations for volumetric analysis. If the results derived from spreadsheet models are linked directly in a BIM environment, the end users can dynamically see the outcome of spreadsheet calculations in graphical format. They can not only see real time graphical presentation of the changes made in input data in the spreadsheets model, but also its effects on other building systems. This will help, architects and planners, better understanding initial rough cost estimates, and other analytical outputs without going through complex mathematical calculations.

The main objective of this research is:

- To provide non-proprietary, open source software solution that can generate initial mass models based on the outcome of spreadsheets in Volume 2 and act as link between the two.

Activities that might be helpful for this research include:

- Research of leading BIM software used in Architecture, Engineering and Construction (AEC) industry today.
- Generate flow chart of bi-directional data movement between spreadsheet models and BIM model.
- Pros and cons of using existing proprietary off the shelf solutions
- Criteria for development of non-proprietary open source software solution that will act as a third party plug-in.

#### 5.6 Passenger Self-tagging of Baggage (from ACRP Report 10 and ACRP Report 41 review)

ACRP Report 41 began to address this topic, but was developed at time when the concept was only implemented in other countries. Now that several US airport are considering or implementing the concept there is a need to revisit the topic. Research problem statement will be developed that will address:

- Regulations regarding positive passenger identification and baggage screening in countries where passenger self-tagging of baggage is allowed,
- Technologies or methods used to facilitate passenger self-tagging,
- Baggage-handling implications of passenger self-tagging, and
- Passenger-processing rates associated with the different methods for implementing passenger self-tagging.

#### 5.7 Bag-check Plaza configuration and Financial Feasibility (from ACRP Report 10 review)

Research problem statement on bag-check plaza configuration and financial feasibility will be developed. The statement will consider:

- Determination of the balance between parking spaces and queuing based on the acceptable time in queue;
- Investigation of the most effective layouts;
- Baggage-handling options for various locations (i.e., close-in versus remote); and
- Potential opportunities to generate additional revenue by combining a bag-check plaza with various parking options.

#### 5.8 Validating Passenger Level of Service and Spatial Planning Criteria for Airport Terminals (from ACRP Report 55 review)

Research problem statements addressing topics below are being refined:

1. Research on best practices of using ethnographic data collection techniques to understand passenger perceptions inside an airport terminal.
2. While the authors' do not advocate more traditional LOS passenger surveys, they advocate more "ethnographic" surveys to understand how perceived level of service is affected by factors that contribute to a reduction of passenger stress (i.e., wayfinding, control of journey time, short walk distances or quick travel times, reliable flight status information, etc.)
3. New data collection survey techniques should be studied to expedite passenger response rates and to track passengers around the terminal. The authors recognize that new mobile technologies such as GPS and Blue Tooth could be used to collect better data at airports. According to the study. TSA and some airports collect passenger wait times at processors using mobile technology.

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<sup>i</sup> SAGA Sustainable Aviation Guidance Alliance

<sup>ii</sup> One of our team members was at an AAAE Airport Innovation Forum in at the Westfield Bespoke Labs in San Francisco, and based on discussions this issue is still relevant and affecting things currently. Seattle is planning for complete self-check now because they are so constrained. It will probably be the first US airport that will fully implement self-tag and self-check.

<sup>iii</sup> At the same AAAE Airport Innovation Forum how concessions are being done was a big topic and an entire afternoon was devoted to this. An integrative approach that being utilized at SFO was discussed and indications from discussions are it may be a future trend.

<sup>iv</sup> BIM is increasingly becoming preferred platform for architects and engineers to design airport terminals. The information extrapolated from the spreadsheet models along with LOS information, can be used to generate non-proprietary generic BIM models for stack planning within early design phases (schematics) using 3 dimensional diagrams. It will also help planner/ designer for volumetric analysis of space

<sup>v</sup> ACRP Report 30: Reference Guide on Understanding Common Use at Airports at [http://onlinepubs.trb.org/onlinepubs/acrp/acrp\\_rpt\\_030.pdf](http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_030.pdf)

<sup>vi</sup> ACRP Report 110 Evaluating Impacts of Sustainability Practices on Airport Operations and Maintenance [http://onlinepubs.trb.org/onlinepubs/acrp/acrp\\_rpt\\_110.pdf](http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_110.pdf)

<sup>vii</sup> ACRP Report 119 Foreword at [http://onlinepubs.trb.org/onlinepubs/acrp/acrp\\_rpt\\_119.pdf](http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_119.pdf)

<sup>viii</sup> ACRP Report 109 Foreword at [http://onlinepubs.trb.org/onlinepubs/acrp/acrp\\_rpt\\_109.pdf](http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_109.pdf)

<sup>ix</sup> ACRP Report 40 Foreword at [http://onlinepubs.trb.org/onlinepubs/acrp/acrp\\_rpt\\_040.pdf](http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_040.pdf)