ACI World Facilitation and Services Standing Committee

Recommended Practice 300A12:
Manual Measurement of Passenger Service Process Times and KPI's

Drafted by ACI World Secretariat and DKMA

Recommended that

Airports wishing to understand passenger flows and bottlenecks around the airport by measuring manually the passenger waiting (queuing) times and other Passenger Services Key Performance Indicators (KPI's), apply the techniques and methodologies described in this recommended practice.

Executive Summary

This document recommends a manual method that is easily understood and easily replicated around the world for airports of differing sizes and types. The methodology is based on ACI's ASQ Performance (ASQP) programme which has been developed over several years in conjunction with 12 airports and proven to work in airports of varying size, all over the world.

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1. Introduction

There are many ways of measuring passenger process times. This document recommends a manual method that is easily understood and easily replicated around the world for airports of differing sizes and types. The methodology is based on ACI's ASQ Performance (ASQP) programme which has been developed over several years in conjunction with 12 airports and proven to work in airports of varying size, all over the world from Europe to Africa to the Middle East.

ASQP was designed specifically to measure delivered service quality levels and the central concept has been to ensure accuracy and comparability of results. This comparability allows airports and the airport industry to work together to create benchmarks and identify true best practice.

ASQP is part of ACI's global Airport Service Quality initiative and is fully compatible with the passenger satisfaction benchmark ASQ Survey – currently used by over 275 airports worldwide – the ASQ Assured airport certification, and the ASQ Retail programme.

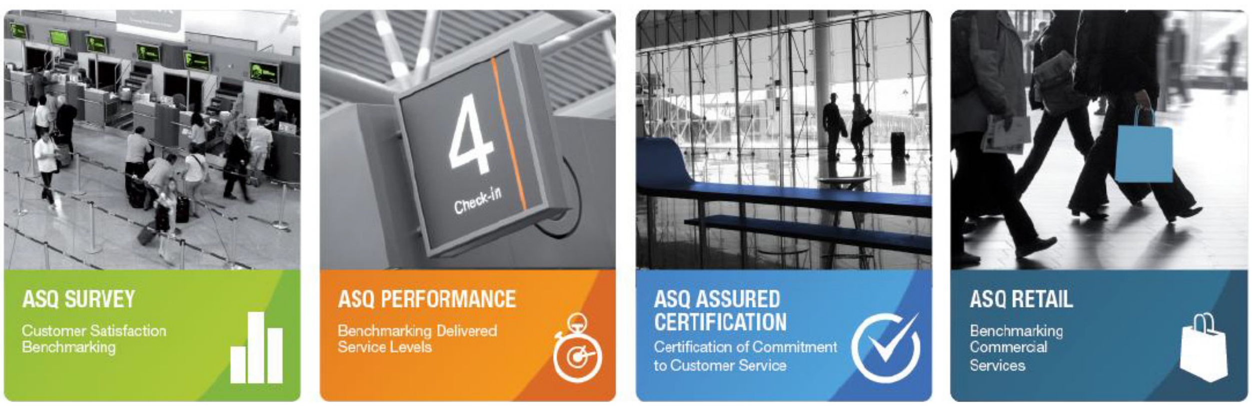

Figure 1: ACI Airport Service Quality (ASQ) programmes

1.1. Long term goals

- Create real world standards for passenger facilitation at airports of all sizes and types around the world.
- Identification of best practice
- Complement the passenger's "subjective quality" assessment by measuring the actual "objective quality" of service delivered
- Improve the passenger experience

1.2. Usage of the data

This document makes no recommendations on how Passenger Process time data should be used. However, it is noted that Key Performance Indicator (KPI) measurements are already being used in a variety of ways such as:

1. monitoring and incentivising teams;
2. as an input into the overall quality management process;
3. as a target or threshold in Service Level Agreements (SLA);
4. to identify key bottlenecks and poor passenger experiences;
5. in conjunction with ASQ Survey, to show how improvements in delivered levels of service can improve customer satisfaction;
6. to calculate the investment required to improve the passenger experience.

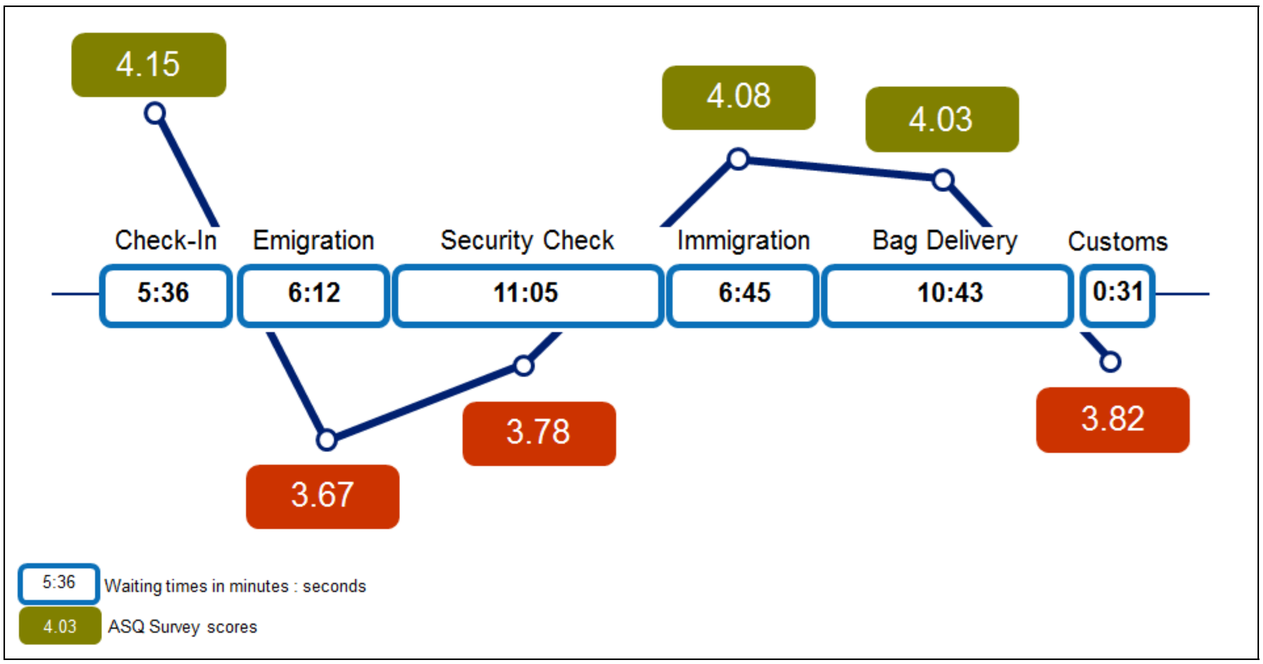

Figure 2: Impact of waiting times in customer satisfaction

2. Key Performance Indicators (KPIs)

As all airports and management cultures are different, there are an infinite number of potential KPIs for passenger service. This document describes the methodologies recommended for the 16 core KPIs that have been shown to be of interest to and relevant to all airports.

Airport customer service KPIs are primarily based on queuing (waiting) times. The main KPI not based on queues is the number of baggage carts available (at various locations around the airport). This is simply calculated as the number of baggage carts counted at each location.

ACI recommends two types of queuing KPIs:

1) Average passenger waiting time: monitors the passenger experience and identifies bottlenecks and the amount of time a passenger spends in queues at the airport.

2) Counter & Checkpoint processing speed: monitors airport and airport employee performance at facilitating passengers through the airport.

	Passenger Process	Key Performance Indicators
Outbound Process	Baggage carts (by location)	Number of baggage carts available
	Check-in	Average waiting time Counter processing speed (pax/hour)
	Passport / Personal ID control (departure)	Average waiting time Checkpoint processing speed (pax/hour)
	Security check-points	Average waiting time Checkpoint processing speed (pax/hour)
	Transfer services	Average waiting time Checkpoint processing speed (pax/hour)
	Boarding process	Time until the last passenger leaves the gate
Inbound Process	Baggage delivery	Time for first bag to arrive on carousel Time for last bag to arrive on carousel
	Passport / Personal ID control (arrival)	Average waiting time Checkpoint processing speed (pax/hour)
	Customs inspection	Average waiting time Counter processing speed (pax/hour)

Figure 3: List of 16 airport customer service recommended KPIs

3. Methodology

3.1. When to measure

To get an accurate view of an airport's performance it is important to measure all year round; this ensures seasonal differences are captured. ACI recommends an airport measures the KPIs every month.

Off-peak hours are rarely of interest as there are generally few queues. Therefore unless there is a concern that reduced service levels are causing queues during off-peak, recommended practice is that airports concentrate efforts on peak hours' measurements. This focus maximises cost-effectiveness.

Recommended practice is that definition of peak hours for sample days is based on current Official Airline Guide (OAG) traffic schedules with input from the airport to include non-scheduled flights.

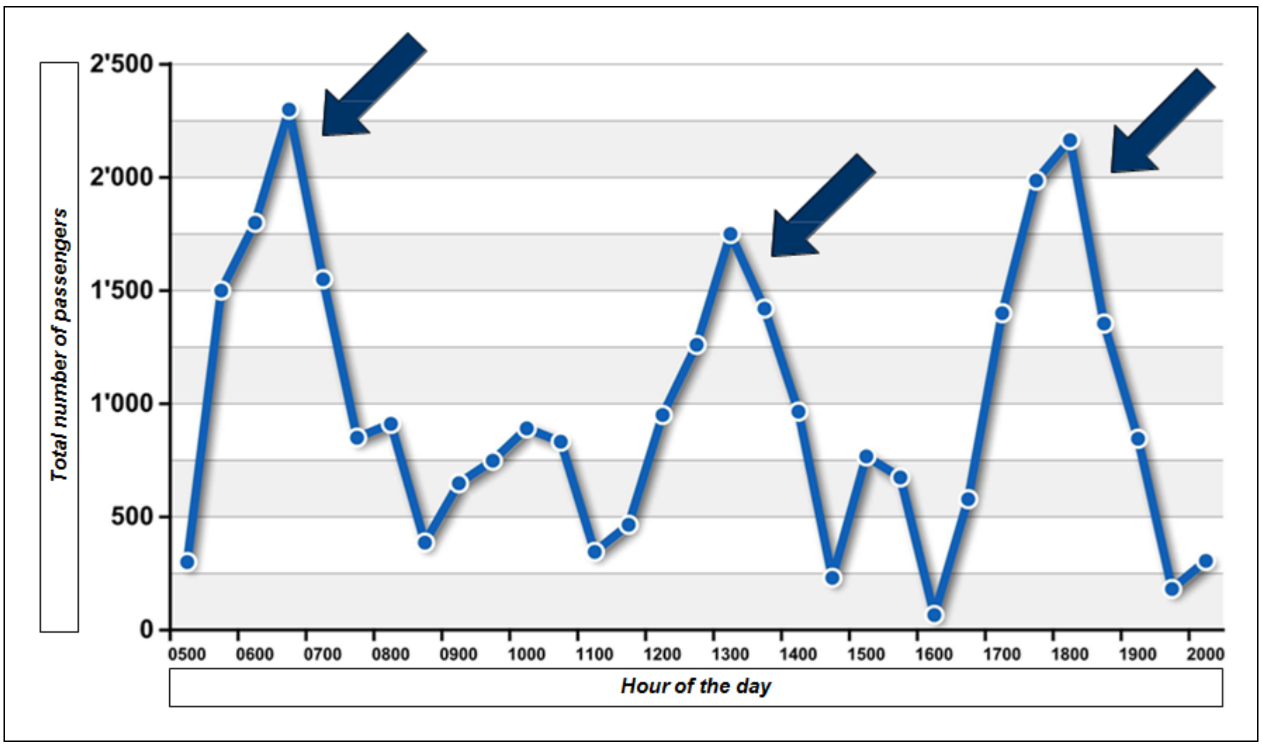

Figure 4: Peak passenger flow based on airline capacity

In order to provide a balanced measurement of peak hours during sample days, it is recommended to select periods of measurement using the same peak hour demand analysis criterion as the one considered for the design of the facilities, taking into account current passenger demand levels.

For more information on peak times and design period calculations, please check the references in Appendix 1.

3.2. Where to measure

To ensure accurate coverage of the airport's facilities and traffic, the OAG traffic schedules (together with airport input for non-scheduled traffic) are also used to create a specific sample plan for each airport. The sample plan is based on the seat capacity offered by airline and ensures that KPI measurement reflects overall airport traffic and is correctly aligned across:

- Terminals
- Gates / piers
- Airlines / Alliances (only the most important airlines accounting for 80% of the traffic will be measured)

Check-In is further segmented according to

- First/Business
- Economy
- Self-Service Check-in Kiosk
- Bag drop off

If there is more than one central security checkpoint, security is segmented according to the individual security checkpoints, then further segmented into economy / business / fast track where relevant.

3.3. How to measure

Methods used around the world include: paper based with stopwatch recording, real time live cameras, thermal images, mobile phone Bluetooth monitoring, indoors GPS, and agent manual counting using computer portable tablets with measurement software. Additional technologies and automated methodologies can be used and are described in Appendix 2.

Some KPIs such as baggage delivery are routinely measured automatically by the airport. Recommended practice is to use these measurements unless there are clear issues observed with the results.

ACI recommended practice for manual measurement (for those airports where this methodology is feasible and applicable) is to use agents using computer portable tablets with airport specific measurement software for the remaining KPIs. Computer portable tablets provide a cost-efficient measurement method without the data gathering and inputting problems of paper. The software is based on a methodology which can be easily and inexpensively extended across the whole airport (unlike Bluetooth or live camera which require substantial initial investments and are subsequently relatively inflexible).

This methodology (and other tablet based software solutions), allows relatively inexperienced observers to take consistent and accurate measurements. Further, the recorded observations can be automatically exported via Wi-Fi connection, reducing paperwork and processing time.

Recommended practice for observers taking measurements is:

- KPIs are measured during peak times of the measurement day (sample day)
- Each queuing KPI measurement is taken over a 1 hour period (60 minutes) during which multiple observations are made. (e.g. 1 hour at Lufthansa check-in, 1 hour at passport / personal ID control)
- Each individual observation lasts for a maximum of 10 minutes
- If the observation lasts less than 10 minutes, repeat observation
- If no queue is observed, wait 5 minutes before the next observation

The 10 minute limit maximises the number of observations that can be taken in a given time and promotes good coverage of the airport and its facilities. This is particularly important measuring check-in queues as the queues wax and wane dramatically during peak hours.

3.4. Sample sizes

A minimum sample size is mandatory to guarantee representative data and useful benchmarking. While the exact sample size is necessarily dependent on the size and layout of the individual airport, a guideline for recommended minimum sample per survey period is as follows:

Services	Measurements
Baggage carts (by location)	100
Check-in	200
Passport / Personal ID control (departure)	100
Security check-points	100
Transfer counters	50
Boarding	50
Passport / Personal ID control (arrival)	100
Bag delivery	100
Customs inspection	20

Figure 5: Recommended minimum sample per survey period

This minimum might be appropriate for an airport with approximately 3 million passengers per annum, but larger airports should increase the sample size where necessary to improve the measurements of complex infrastructure or fit research requirements

3.5. Measuring queue times

The aim of the measurement is to be able to calculate average passenger waiting time and the average counter/checkpoint processing speed. To achieve this, the airport needs to know:

- Number of counters available to a passenger at the beginning and end of the measurement
- Time taken to progress through the queue

In order to ensure coverage over the entire hour, measurements last a maximum of ten minutes and are structured to provide the required information.

There are typically two types of queue observed in airports:

1) Disney (one line serving multiple counters)
2) Single line (one line serving one counter)

The type of queue observed should always be recorded as the recommended practice for measuring these queues is slightly different and the data analysis and processing required is different.

Recommended practice for measuring the two types of queue is as follows:

3.5.1. Disney queues (one queue serving multiple counters/checkpoints)

The observer starts the observation (or records the time) when a passenger leaves the queue to go the counter. At the same time, the observer identifies the last person in the queue. Once the observation has started, the observer counts the number of passengers in the queue, and the number of open counters available to passengers in this queue. The last passenger should be included, but not the one going to the counter.

To conclude the observation, there are two possible scenarios:

1) The "last passenger" arrives at the counter in less than 10 minutes. The observer records the time and the number of counters which are open for this queue.

2) If the "last passenger" is still queuing after 10 minutes, the observer notes that the 10 minutes has elapsed and counts the number of passengers in front of the last passenger and the number of open counters available to this queue.

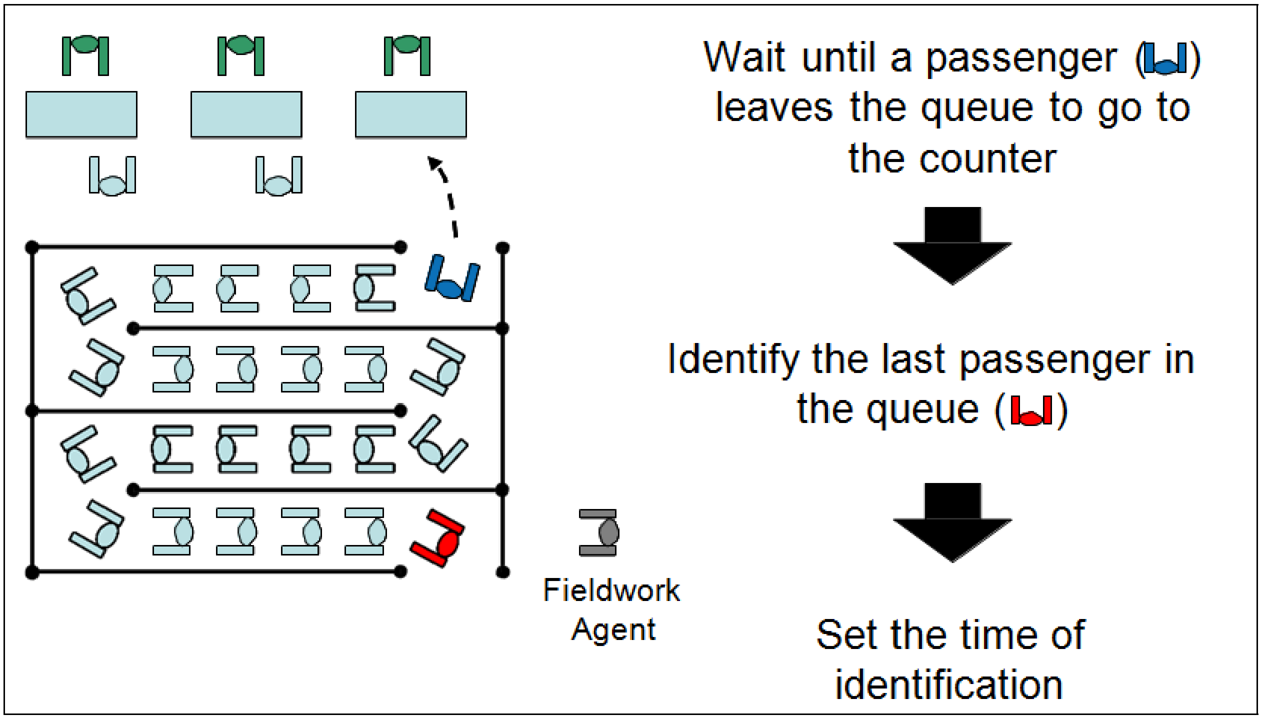

Figure 6: Measurement process for Disney queues

3.5.2. Single queues (one queue serves one counter/checkpoint)

The observer identifies the longest queue and then starts the observation when a passenger leaves to go to the counter. The observer counts the number of passengers in this queue, as well as the total number of people queuing in all lines available to this passenger (in the case of check-in, only for this airline/alliance and this class of check-in). The count should include the last passenger, but not the one(s) going to the counter(s). Finally, the observer counts the number of open counters available to this passenger.

To complete the observation, there are again, two scenarios:

1. If the “last passenger” arrives at the counter in less than 10 minutes, the observer records the time and counts the number of open counters available to the passenger.

2. If the “last passenger” is still queuing after 10 minutes, the observer notes that the 10 minutes has elapsed, counts the number of passengers in front of the “last passenger” and records the number of open counters.

If there is no queue:

- Recommended practice is that the observer should record that the number of passengers is zero, queuing time is zero and the number of queues is zero. The observer should also count the number of open counters / machines
- It is important to record empty queues as well as full queues. Airport queues vary considerably even during peak hours and in order to gain a realistic view of passenger waiting times, an average should be taken.

- After measuring an empty queue, the observer should wait 5 minutes before making the next observation.

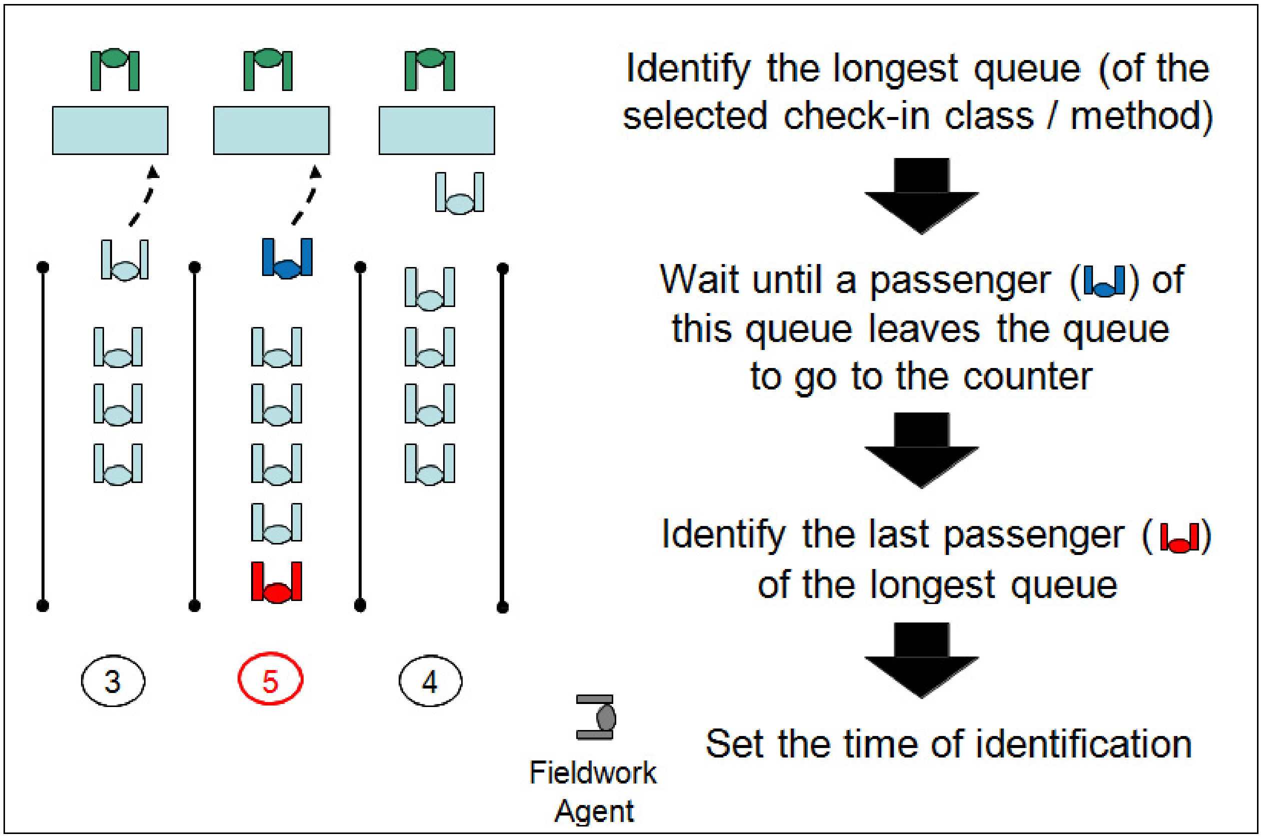

Figure 7: Measurement process for single queues

3.6. Recommended practice for different areas of the airport

3.6.1. Check-in

A sample plan should be created for each airport based on the seat capacity offered by airline. The sample plan will identify:

- Terminals
- Airlines / Alliances (only the most important airlines accounting for 80% of the traffic will be measured)
- Check-In segmentation: First/Business, Economy, Self Check-in Kiosk, Bag drop off

Each measurement is specifically dedicated and is defined as one hour of measuring one queue. For example, one hour is spent measuring Economy class passengers flying Lufthansa, part of Star Alliance, in Terminal 1.

This detail is important to gain a realistic overview taking into account the natural ebb and flow of each type of queue.

3.6.2. Passport control

If several types of control counter (e.g. local / non-local / all passengers) exist at a control point, measure each counter type separately during each survey.

3.6.3. Security control

Recommended practice is to measure average waiting time at each security check-point and the average processing time at each type of security-check lane.

If the security check point has separate lanes for Business and Economy (or others e.g., Fast Track), it is important to measure each type of lane separately for each measurement.

If applicable, Fast Track should be treated as a Business lane.

Recommendations for security checkpoint measurement process

Start the measurement:	When a passenger puts his / her basket on the belt of the X-ray machine.
End the measurement:	When the last identified passenger puts his / her basket on the belt of the X-ray machine.

3.6.4. Transfer counters

Recommended practice is to measure average waiting time per airline / ground handler and average processing time by type of counter.

The airport should make a selection of the most important transfer service centres based on its home carrier and the infrastructure.

3.6.5. Boarding

Measurement of the boarding times is different to other queues. Boarding measurement should be for pre-defined flights, from opening of the gate until the last passenger enters the aircraft.

A sample plan should be created for each airport specifying which flights need to be surveyed. The selected flights remain unchanged during the year of measurement.

To begin the observation, the observer should first set the time of observation and then write down the flight number, 3 letter code of the flight destination, airline, terminal, gate number and aircraft model.

The observer then asks the staff how many passengers are planned for the flight.

The observer should record whether the gate is a:

- Closed gate: passengers are no longer permitted to leave the gate and tickets have already been swiped;
- Open gate: passengers are allowed to move around freely in and out of the gate.

The observer should record how passengers will reach the aircraft and select one of:

- boarding bridge
- bus
- walking

The observer should note the time the first passenger gives its boarding pass to the staff at the gate reader then count the number of staff and the number of gate accesses.

Finally the observer notes the time the last passenger leaves the gate:

- Closed gate: when the last passenger leaves the pre-boarding area to enter the boarding bridge, walk to the aircraft or to take the bus
- Open gate: when the last passenger gives its boarding pass to the staff

3.6.6. Baggage delivery

Many airports measure these times automatically (e.g., when the baggage belt is switched on). In these cases, these measurements do not need to be replicated.

For any other cases, for a pre-selected flight, the observer waits for the inbound aircraft to come to a complete stop at the stand and notes the time chocks are put on.

The observer then goes into the ground handling area (airside), records the arrival terminal and carousel number and notes the time the first / last bag is placed on the conveyor belt.

3.6.7. Customs inspection

The red channel designates the customs section where a passenger voluntary declares importing goods or where the passenger is sent by the customs supervisor.

The channel can be treated as a single queue, and the methodology will be similar to the one described for the security checkpoints.

3.6.8. Baggage Carts

The specific locations to be measured around the airport need to be determined before the start of measurements. The observer counts the number of baggage carts stacked up at the pre-selected locations in the terminal in departure and arrival areas as well as in the parking facilities.

4. Acknowledgements

ACI World would like to recognise the input from the following companies and entities in drafting and reviewing this Recommended Practice:

- DKMA
- ACI World Facilitation and Services Standing Committee

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Appendix 1: References

For more information on peak times and design period calculations, please check the following references:

- International Civil Aviation Organisation (1977) Airport Planning Manual - Part 1. Master Planning, Doc. 9184 - AN/902, ICAO, Montreal.
- Planning and Design Guidelines for Airport Terminal Facilities. Advisory Circular 150/5360-13. U.S. Department of Transportation, Federal Aviation Administration. (1988).
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- Airport Cooperative Research Program – ACRP Report 25 – Airport Passenger Terminal Planning and Design, Volume 1: Guidebook. Transportation Research Board, 2010.

Appendix 2: Passenger Counting Technologies

Passenger Counting Technologies - Comparison Fact Sheet (developed by ACI and SITA)

The purpose of this fact sheet is to provide an understanding of the various passenger counting and tracking technologies currently available, as well as those technologies that are emerging. The information presented in the following pages is a neutral view of the pros and cons of the technologies at this point in time, and believed to be accurate, but not warranted. This Appendix will be updated regularly, as the technologies continue to evolve.

APPENDIX 2

Passenger Counting Technologies - Comparison Fact Sheet (developed by ACI and SITA)

The purpose of this fact sheet is to provide an understanding of the various passenger counting and tracking technologies currently available, as well as those technologies that are emerging. The information presented is a neutral view of the pros and cons of the technologies at this point in time, and believed to be accurate, but not warranted. This Appendix will be updated regularly, as the technologies continue to evolve.

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Technology (and attributes)	Pros	Cons	Typical Application
BCBP **(Bar Coded Boarding Passes)** • BCBP events are captured when they are initially generated by the DCS to be printed or issued to a mobile device and then subsequently scanned, e.g., at security, boarding, etc.	• Proven, stable solution • Ability to capture up to 100% of passengers • Anonymous, flight based tracking available • Potential to uniquely identify the passenger • Affordable solution	• Limited scan points • One of the less granular methods of tracking • Requires involvement from passengers • Off airport check-in passengers are only "seen" when first scanned at the airport.	Can provide: • Validation of 100% of passengers through a checkpoint, typically going airside from landside • Approximate passenger counts (manually boarded passengers cannot be tracked) • Coarse dwell time analysis, e.g., time from airport check- in to security to boarding • Time last passenger checked in at the airport

Technology (and attributes)	Pros	Cons	Typical Application
Bluetooth • Tracks on the basis of the Bluetooth device's address, which is typically translated to a unique, anonymous identifier • Sensors are adjustable within a range of 1 to 10 meters (3 to 30m with directional antennas) • Typical penetration rate ranges from 8 to 15% of passengers (potential to increase with the future use of passenger facing applications, e.g., flight updates) • Bluetooth devices can be probed multiple times a second for very granular, accurate tracking • Uses the same ISM 2.4 GHz frequency as Wi-Fi (802.11g), without material interference (given low power output, e.g., 1/1000th the power of Wi-Fi)	• Proven within the industry, as airport deployments date back to 2006 • Tracking is typically anonymous • Potential to track and communicate with passengers uniquely, e.g., proximity marketing (though IP based communication is a better choice for interacting with passengers, e.g., via mobile apps) • Bluetooth is more likely to be electronically visible, assuming that it is turned ON, due the basic inquiry- response functionality of the protocol • Requires virtually no maintenance, e.g., no calibration	• Maximum height from ceiling of 3-4 meters (where ceiling mounting is not possible, sensors are typically affixed to available infrastructure, e.g., pillars) or mounted on end of pipes extending down from the ceiling. Ceiling height can be up to 6-8 meters using directional antennas. • Without an active Bluetooth application/connection, e.g., hands free, Android phones cannot be tracked via Bluetooth as they are only in "discovery mode" during the first two minutes after power-up • In some airport locations, a decrease in Bluetooth usage has been detected	• Well suited to queue management, and can be used for tracking passenger movements and dwell time throughout the airport (even from the public highway infrastructure exits, through to parking structures, check-in, immigration, security, retail to the final destination gate)

Technology (and attributes)	Pros	Cons	Typical Application
Wi-Fi using RSSI (signal strength) for geolocation of passengers • Emerging • Tracks on the basis of Wi-Fi device's "mac" address, which is translated to a unique, anonymous identifier • Sensor (access point) range of 2-3 meters and up to 100 meters (depends upon density of access points, type of access points, type of passenger's phone device and usage of the phone) • Access point placement must be designed for proper triangulation • Best practice recommends that access points should be placed within 25 meters apart, within line of sight of 3 other access points for accurate tracking • Sample size estimates currently range from 10 to 15%	• Ability to uniquely track and communicate with passengers (opt-in only) • Multi-purpose application support, e.g. Wi-Fi access by portable devices, and geo-localisation of people and assets • Sample size is expected to increase as more passengers adopt smart phones and airports move to provide free WiFi	• The frequency and accuracy of detection points is limited when the phone is not in active use (e.g. in sleep mode). The rate drops off to once every two minutes (depending upon the phone) • Not suitable for granular lane based queue time measurements (e.g. measuring queue wait times at individual check-in, security or immigration lanes) • Requires roughly 2.5 times more access points to support granular triangulation • Requires radio survey to determine radiation in order to trim the triangulation. This survey has to be repeated if building facilities changes.	• Well suited for zone based tracking & storing passenger movements, and dwell time throughout the airport • Preferred technology for marketing communication via concierge type applications on smart phones.

Technology (and attributes)	Pros	Cons	Typical Application
Video Analytics (option 1: visual light spectrum) Video Analytics is a broad category with many variations (see other options below): • Tagging and tracking heads within a contained area • Also used for people counting (with movement in dual directions) • May be used to augment Bluetooth tracking with video streaming of tracked individuals	• Able to both track (within camera viewing area) and count passengers with a single technology • Ability to tag and track ~ 100% of passengers (within multi- camera viewing area, within a contained area, e.g., security) • Potential to use existing CCTV cameras	• Can only track passengers within a contained area, e.g., security, and not throughout the airport, as the entire airport cannot be covered by cameras, e.g., WC • No potential to identify or communicate with the passenger uniquely • Requires regular maintenance in form of cleaning and calibration check to guarantee accuracy • Light sources or sunlight reflections can impair the technology without being able to centrally detect such occurrences • Requires expensive computing and storage servers compared with alternative technologies • Typically requires more cameras than sensors of competing solutions	• Localized queue monitoring/management • Most references for Video Analytics are in the area of retail and surveillance, and intrusion detection

Technology (and attributes)	Pros	Cons	Typical Application
Video Analytics (option 2: Biometrics) • Tracking via facial recognition	• Can uniquely ID and track the passenger without having total coverage of airport with cameras	• Trialling facial tracking, one airport reports a 3% sample rate across the airport	
Video Analytics (option 3: thermal/visual fingerprint) • Evolving (future) Passenger tracking on the basis of a "thermal/visual fingerprint" using size/shape/thermal and/or color metrics	• Could uniquely ID the passenger, and then in theory, track the passenger without having total coverage of airport with cameras		• A similar technological concept is used to screen passengers' corporal temperature to control outbreaks of communicable diseases

Technology (and attributes)	Pros	Cons	Typical Application
GSM • Sensors can be located as far as 100 meters apart • Can triangulate down to 2-5 meters • Sample rate in the range of 25-45%, which varies by geography • Sensors use the "tinsey" signal which is a temporary address, which varies by location	• Potential for high penetration rate	• Probe time is inconsistent, as 40% of phones probed within 2 minutes, and can range between 12-20 minutes (using GSM, is not possible to force transmission). Conversely, Bluetooth and Wi-Fi devices can be proactively probed) • As tracked "address" is temporary, return visits cannot be tracked • Not suitable for short process measurements such as security queue time reporting, due to low sample rate • Requires recalibration if facility changes significantly such as a result of store redesign	• Ideal for tracking within shopping malls where typical movements are casual and shoppers tend to linger

Technology (and attributes)	Pros	Cons	Typical Application
Thermal Imaging • Mature, robust people counting technology • Counts passenger movements in two directions • Able to count multiple passengers at the same time • Counting accuracy ranges from 95-98%	• Proven • No maintenance required Sensors are small in size compared to alternatives • Long lifetime	• Indoor use only	• Frequently implemented as an extension of Bluetooth people counting systems (60% of Bluetooth systems also include people counting)

Technology (and attributes)	Pros	Cons	Typical Application
Laser Counting • Mature, robust people counting technology • Ability to count over wide areas	• Proven • Preferred technology for outdoor counting applications due to resistance to interference from sun reflections and other light sources	• Typically more expensive than thermal imaging sensors • Limited life time as devices have rotating parts • Requires regular maintenance such as filter changes and cleaning • Uses more power than alternatives • Large physical size • Expensive to install and calibrate compared to alternatives	• Implemented as an extension of Bluetooth people counting systems (60% of Bluetooth systems also include people counting)
RFID • Used for asset tracking (over Wi-Fi) • RFID chips now being placed within passports		• Has not emerged as a viable alternative for passenger tracking, as it requires a relatively costly token (RFID chip) • Has very short communication range (in relation to passport usage) • Domestic passengers typically do not carry passports	• Could be used in relation to temporary measurements initiatives where passive RFID has been applied to each boarding pass

Technology (and attributes)	Pros	Cons	Typical Application
NFC (Near Field Communication) • Emerging • SITA Lab involved in a pilot involving NFC to store boarding card on a device (phone) and use it at security gates, boarding gates and airline lounges for automatic entry	• This technology is similar to the BCBP and Passport RFID as the passengers' NFC device (typically a phone) has to be presented very close to the reader	• Has not emerged as a viable alternative for passenger tracking, as communication range is limited • Technology penetration will be low for the next 1-3 years	• Used for personal identification, like driver license, payment, access control etc.
Wi-Fi TOA (Time of Arrival); Time stamped based versus current RSSI methodology • Access points are time synchronized • 3-5 meter triangulation • In trial phase	• Requires less access points than Wi-Fi access points using RSSI • Consistent accuracy versus RSSI based tracking (to be confirmed, via a trial) • Less impact by barriers, e.g., walls than RSSI	• Relatively new, and untested • Requires proprietary access points • Need to run a parallel network to Wi-Fi access points	

Technology (and attributes)	Pros	Cons	Typical Application
UWB (Ultra Wide Band) • Emerging • Wi-Fi specification (802.15) Allows for high precision short terms sensing, e.g., down to cm	• Low power, doesn’t interfere	• Few market solutions available • Wi-Fi chip set in access points needs to support needed protocol	
iGPS (indoor GPS) • Emerging • Uses Wi-Fi spectrum • Piggy back upon GPS protocol (enables outdoor indoor seamless tracking) • Need fewer sensors than TOA • Trial phase	• Lower number of sensors than RSSI (less infrastructure) • Less than one meter precision	• Needs a chip set upgrade to • Wi-Fi access points	

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