BEUMERGROUP

AIRPORTS 2025 OUTLOOK:

REINVENTING THE AIRPORT EXPERIENCE

LETTER FROM THE DIRECTOR: AIRPORTS READY FOR THEIR NEXT CHAPTER

Every year, our Airport Report does its best to identify the trends and problems prevalent in the airport industry, along with a wide range of solutions. But ever since 2020, there has been one constant.

Today though, in 2024, we can say it with confidence: the shadow of the Pandemic has finally lifted.

Passenger numbers are finally on a par with 2019: it's fair to say the airport industry has regained its trust in the continuous growth forecast in the 2010s.

There were doubts whether travel behaviour would change following the Covid restrictions – particularly business trips due to the popularity of meeting online. But the anticipated dip hasn't materialised. Business travel is back where it was.

2024 will be remembered as the year in which we are finally able to start a new chapter in the story of airports.

The airlines are coping with the extra peaks of demand, they're earning good money again, and they want to invest in more capacity – the aircraft order numbers of Boeing and Airbus prove this.

India is a great example: air travel is booming like its economy, and there have been hundreds and hundreds of aircraft orders.

Another example is the revival of the A380 – they're back in demand because airlines need the extra capacity.

INVESTMENT IN INNOVATION THE BEST REMEDY FOR PAIN POINTS

The missing capacity is a problem given the unprecedented number of mega projects to build airports to service 60-100 million passengers a year – normally projects like these are seen once in our lifetime, but this is three or four in as many years.

In line with this, interest in innovation is picking up after decades of stagnation – although still the old questions persist: "Can you show us the references?" No, this is the nature of innovation.

Innovation is paramount because scaleability will be key when dealing with peaks of demand, and most airports aren't equipped to cope.

Missing capacity is certainly a major pain point – labour shortage is another. That's why the industry needs to automate to make their operations more efficient and improve performance.

More and more airports want automation for their baggage handling – from self-bag drops to beyond the belts, sometimes all the way to the aircraft – because they want to be the best and have the happiest passengers.

STILL PLENTY OF SCOPE FOR IMPROVING THE PASSENGER EXPERIENCE

Solving potential baggage problems and embracing digitalisation are the surest way of raising the passenger and airlines satisfaction levels.

The airlines are investing in the passenger experience, but they're concerned if this ambition isn't matched by the airports – and certainly, in recent years, many airports in Europe and North American have watched on as their Asian rivals raise the bar.

Security is an obvious area to innovate. During the restrictions it was like a horse market: long queues and staff shouting orders, taking passengers to the limit of their patience. And today it remains one of the biggest causes of stress.

So de-stressing Security has become a main focus: a calm experience lifts the passenger experience and results in them entering the Departure Hall in a good mood, likely to spend more at the outlets.

Another area of interest to the innovators is arrivals where passengers often have to wait too long for their luggage. But what if they could pick up their luggage at a time of their own choosing?

Instead of waiting, they could instead pass through customs – have lunch or a meeting, or freshen up – and then be notified when their luggage is ready to be picked up.

LETTER FROM THE DIRECTOR: AIRPORTS READY FOR THEIR NEXT CHAPTER

FOCUS ON ESG RESPONSIBILITY TRENDING AMONG AIRPORTS

Another major part of the passenger experience is making them feel better about flying.

Passengers need to know they're flying from a sustainable airport, so airports are increasingly reshaping their image to remind them about their ESG responsibility – through their buildings, energy use and the working environment, for example.

Of course, the airlines want to be green, but the technology to make this happen is going to take time to develop. The airlines, though, can move much faster – so this is definitely trending in the industry right now.

Sustainability dashboards, for example, can help visualise KPIs for the operators: from energy consumption to use of capacity. But how sustainable are airports that are only busy a couple of days a week, or a couple of months a year?

That's why 'Airports of the Future' won't just be visited by air passengers – they'll also serve other purposes.

HOW 'AIRPORTS OF THE FUTURE' WILL MAKE SUSTAINABLE USE OF THEIR BUILDINGS

Changi Airport in Singapore, for example, is a big hit with its local community, drawn in by the attractions and retail and food outlets.

Barely a month goes by without something new opening. Most recently the Jewel, an enchanted garden and themed activities – it's no wonder it's a huge hit with Singapore residents.

Salzburg Airport, meanwhile, has reinvented itself as a business convention venue. Originally, it built its Amadeus Terminal 2 to handle the extra demands of the skiing season, but when it's off-season it switches over to conferences.

More and more airports will have to ask themselves the same question in the future: How else can we utilise buildings we have spent so much money on.

"More and more airports will have to ask themselves the same question in the future: How else can we utilise buildings we have spent so much money on."

Ronald Willems,
Division Director Airports Global
BEUMER Group

STATE OF THE INDUSTRY: WHY THE PASSENGER FOCUS IS PARAMOUNT

Chinese restrictions made air travel difficult from 2020 until 2022, but they returned in heavy numbers in 2023. By November, 90 percent of Chinese commercial aircraft were in service – compared to 79 percent worldwide.

This surge in Chinese passengers contributed to a significant milestone a month earlier, when global flying hours accounted for 101 percent of those flown four years earlier in 2019 – the recovery yearned for so long by the industry.

But while 2023 will go down in history as the year in which aviation finally caught up with 2019, it is 2024's task to surpass it, and Airports Council International (ACI) World figures predict it will fly 9.4 billion passengers – 102.5 percent of 2019 levels (2023: 94.2 percent).

HELD BACK BY LABOUR SHORTAGES

While passenger numbers have recovered, the labour shortages caused by the Pandemic have not – an acute problem, as anticipated growth over the rest of the decade will require 680,000 skilled workers, 590,000 pilots and 920,000 cabin crew, according to the Global Services Forecast published by Airbus in October 2023.

Among the skilled workers are many baggage system operators and baggage/ground handlers. Many skilled workers departed with know-how that can't be easily replaced. Their replacements, meanwhile, need training. A drive to attain and retain workers from increasingly diverse backgrounds, and also upskill existing employees, is vital to the industry's future.

The continuing labour shortages underline why it is more important than ever for airports to embrace automation technology, or risk being left behind.

Ultimately, the different processes at the airports of the future – check-in, security, BHS, ground handling – will no longer be isolated, but rather tied together.

NOT INVESTING: NO OBVIOUS DOWNSIDE ... BUT NO UPSIDES EITHER

Tying the processes together enables the airport to raise the passenger experience and ultimately increase their revenue. But what happens if an airport doesn't invest? Can they realistically expect an exodus of customers?

A poor reputation could theoretically result in passengers seeking routes from a nearby airport – it is believed over 60 percent of Europeans live within two hours' drive of at least two airports.

But are they really prepared to factor in another two or three hours of travel at the start and end of their round trip just because they don't like the most convenient choice of airport?

It's true the airport might lose ground on competitive routes, but surveys suggest the airport's location is far more important to passengers than the services it might provide.

According to one survey, UK passengers will always choose their local airport unless there is a huge cost incentive to travel elsewhere.

For example, if Airport A is 100 km away and Airport B is 140 km away, the cost of the ticket from Airport B would need to be at least 40 percent cheaper than Airport A.

INVESTING IN PASSENGER EXPERIENCE AS NUMBERS CONTINUE TO GROW

Nevertheless, this does not mean airports do not have an incentive to invest.

Airports know happier passengers will be inclined to spend more, so they can expect to recoup their investments through future profits. And as of November 2023, passenger revenue had very nearly returned to 2019 levels.

In November 2023, the global figures accounted for 99 percent of the total four years earlier, according to International Air Transport Association data.

Airports are credited with offering improved passenger facilities and operations, transforming themselves into destinations that are desirable to visit.

SURVEY REVEALS DIP IN PASSENGER SPENDING

However, investment in the US has been limited over the last decade, so it is not surprising to note that passenger spending has also been in decline.

As of November 2023, only 51 percent matched their 2019 revenue for passenger spending.

STATE OF THE INDUSTRY: WHY THE PASSENGER FOCUS IS PARAMOUNT

A 2023 survey by AeroCloud of airport leaders in the country revealed that 48 percent are experiencing financial uncertainties and 67 percent foresee a slump in passenger spending.

Additionally, 45 percent are severely hampered by staff shortages posing operational risks and 26 percent have terminal space constraints.

Some 89 percent plan to apply for funding from a federal pool worth $1 billion – a drop in the ocean given that Airports Council International – North America estimates US airports require $151 billion over the next five years to meet their infrastructure needs.

And this sum could rise even further in light of the recently enacted federal rule on refunds for significantly delayed baggage returns, which stipulates:

"Passengers who file a mishandled baggage report will be entitled to a refund of their checked bag fee if it is not delivered within 12 hours of their domestic flight arriving at the gate, or 15-30 hours of their international flight arriving at the gate, depending on the length of the flight."

IMPORTANT FINDINGS FOR AIRPORTS THAT WANT TOP RETAILERS

George Richardson, the CEO of AeroCloud, believes the survey is not just vital reading for airports in the US, but worldwide too:

"Airports need to track passengers and understand their behaviours significantly better than they are doing at the moment. And that has a two-fold benefit, as it contributes to passenger experience, but also we can see how passengers spend and therefore drive insights into how we can increase the spending per passenger."

Airports, urges Richardson, will only attract top retailers to their terminals if they believe in their potential and start collecting more data.

"I think airports need to get more confident about asking third-party vendors to contribute data to the airport. Traditionally, a regional airport has been incredibly grateful to have a Dunkin Donuts or a Starbucks, for example.

Whereas now Dunkin Donuts and Starbucks are incredibly grateful to have those positions at the airport."

RECIPE FOR RECOVERY WITH RIGHT APPROACH TO PASSENGERS

AeroCloud recommends airports focus on four key areas moving forward:

- Attracting new airlines
- Enhancing the passenger experience
- Boosting passenger spending at the terminal
- Upgrading technology to manage operations

The potential is there, concludes Richardson, who points out 50 percent of US airports have not fully restored pre-pandemic routes and, despite the financial uncertainties, 92 percent prioritise replacing legacy technology with automation to enable seamless journeys:

“There is a seismic change in federally funded airports, as they start to hire people from the private sector and drive KPIs into those airports to produce results because they see them as great money-making machines.”

So in answer to the question at the beginning of this introduction, it is very important that airports invest, or they risk being left behind.

Continue reading this report to discover why enhancing the passenger experience and upgrading technology will enable airports to boost spending in the terminal and attract new airlines.

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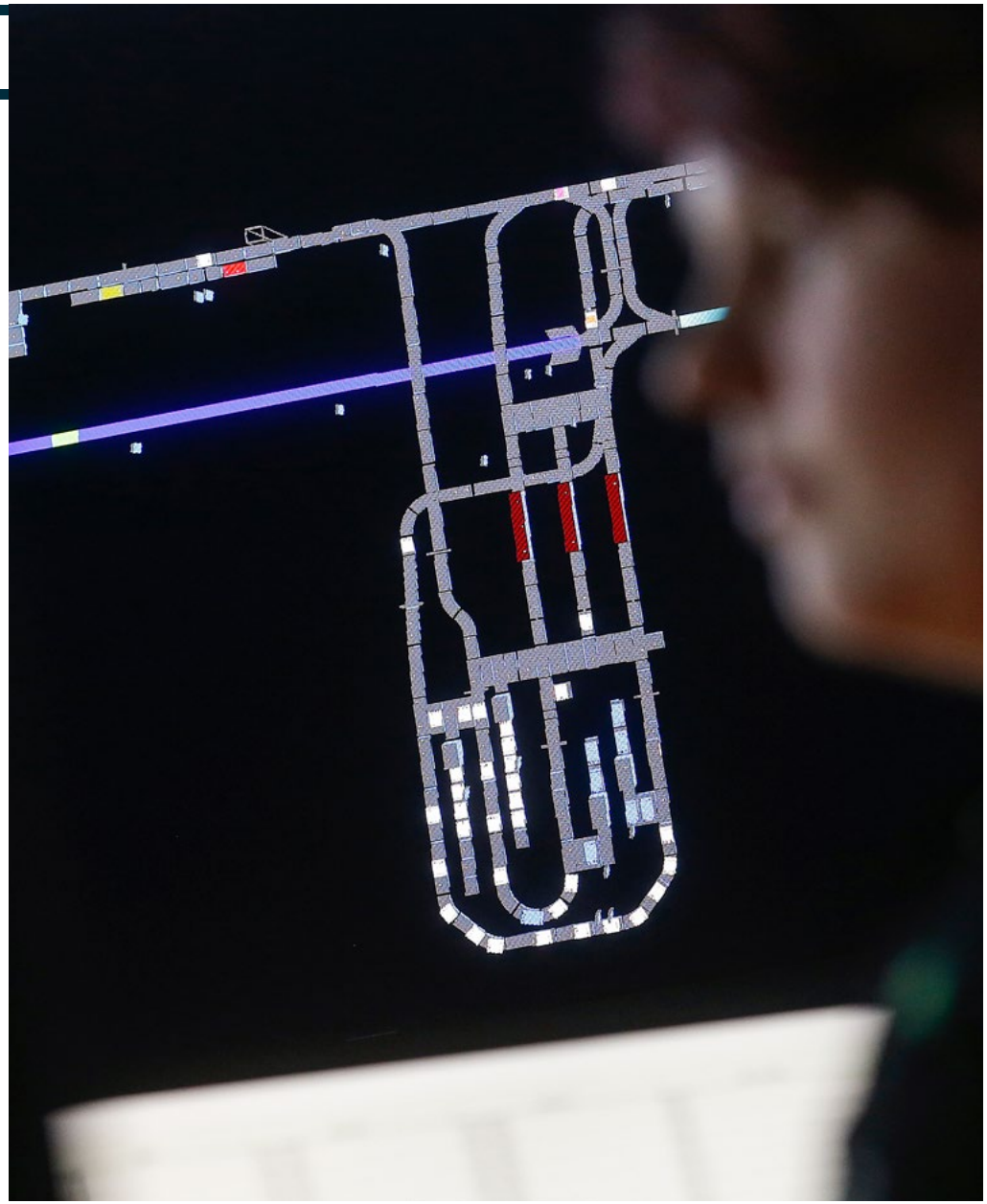
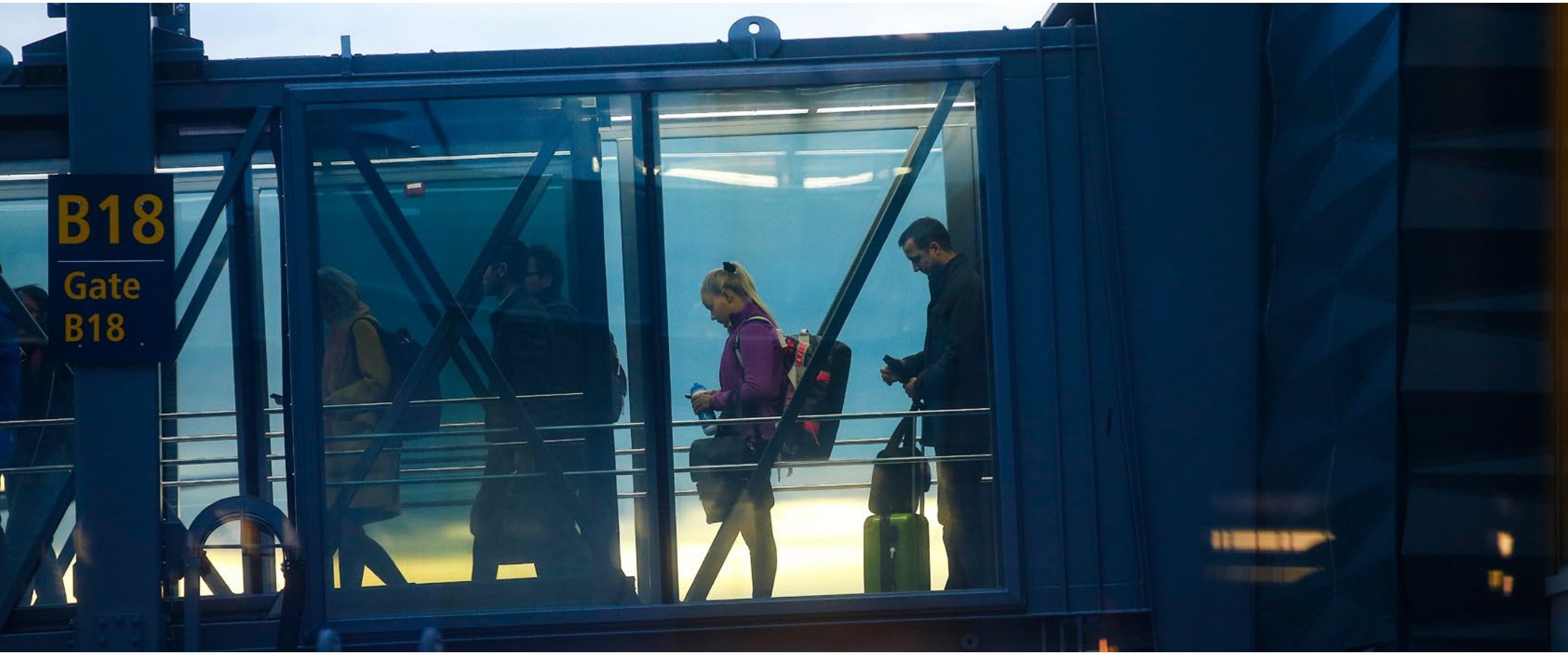




CHAPTER 1:
HOW AUTOMATING SECURITY SCREENING CAN MAKE PASSENGERS HAPPIER

Such is the nature of air travel, the passenger experience is never guaranteed, but airports can narrow the odds in their favour by optimising their operations.

Accordingly, airports are increasingly waking up to how important it is to ensure passengers are masters of their own itinerary: digital ownership of their experience through smart apps and automation are key to achieving this.

One potential stumbling block is Security Screening: airports have taken great strides in automating and speeding up the check-in experience, but these efforts may be in vain if passing through Security Screening is lengthy and problematic.

However, new technology can ensure passengers quickly and smoothly access the Departure Hall, giving them more time to relax and visit the outlets.

Not only are happier passengers inclined to spend more, thus increasing the vital revenue per passenger indices, but the automation of Security Screening will enable airports to reduce their staffing costs by 30 percent and also require less costly hardware.

Airports therefore have two areas through which they can expect to recoup their investments through reduced OPEX spending.

WHY MANY ENTER SECURITY SCREENING ELATED AND LEAVE DEFLATED

Passing through Security Screening is a known cause of stress to 46.5 percent of all travellers. It is with a collected deep breath that many passengers approach Security Screening – the source of so many broken travel dreams – in anticipation of seeing lengthy queues.

But even if it isn't busy, airports reduce the number of Smart Security Lanes (SSLs) in operation in sync with demand, so there will almost always be a wait: a time many spend worrying about missing their flights and cursing the slowcoaches ahead of them.

Many will worry they're being regarded in the same way should they forget to separate their liquids, laptops and belts from the rest of their possessions – all under the guise of Security Screening staff who are rarely patient.

The anxiety continues when their valuables are spread out across five trays before disappearing from their sight as they wait, often without footwear at this point, to be scanned – and possibly even searched.

3D illustration of the Sectro Solution with passenger flow and key areas.

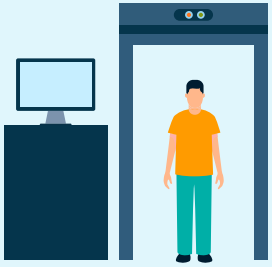
What part of traveling to or through an airport do people find the most stressful?

38 %

Arrival

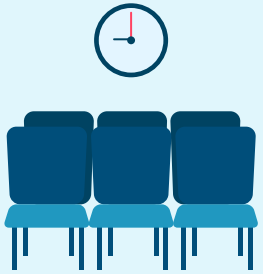
43.7 %

Check-in



46.5 %

Security



28.5 %

Departure lounge

38.5 %

Walking to the gate

32.5 %

Boarding

31 %

Finding your seat

33 %

Storing hand luggage

THREE DIFFERENT APPROACHES TO IMPROVING SECURITY SCREENING

The potential automation of Security Screening is exciting, as it is one of the few processes on the passenger's journey from check-in to boarding that is not in some way automated.

Most importantly, automation helps alleviate staff shortages in the Security Screening area, which continue to force airports to embrace innovation – for example, Schiphol Airport in Amsterdam is trialling automatic wheelchairs in a bid to free up staff.

Let's take a look at three different ongoing initiatives with the potential to improve the Security Screening process.

- **Changes at Aeroporti Di Roma** – a few changes to its Security Screening processes have resulted in quicker, more efficient passenger flows
- **Frankfurt Airport** – pursuing an initiative that enables passengers to pre-book a slot for Security Screening
- **The SECTRO system** – a new solution (at pilot project stage) for hand baggage screening that no longer requires passengers to take items out of their luggage. Instead, everything – luggage, belongings – go in one slightly longer tray. The solution promises to reduce waiting times, lower staffing challenges and increase passenger satisfaction.

SIMPLE SOLUTION REDUCES ENDLESS STRESS IN ETERNAL CITY

New tech is enabling passengers at Aberdeen Airport to pass through Security Screening without taking out their laptops or liquids (up to two litres) – all thanks to the introduction of next generation Security Screening checkpoint (NGSC) scanners.

Similar tech has been in place at Aeroporti Di Roma since early last year, and the upshot is a quicker throughput. Last summer, 90 percent passed through screening in under four minutes, and up to 99 percent in fewer than six minutes.

The technology is still evolving, Marco Stramaccioni, the Chief Executive Officer of ADR Security at Aeroporti Di Roma, told International Airport Review:

"The C3 machines are very big and weigh a lot; they need to become smaller over time in order to be adaptable to all the checkpoints. And also the automatic detection using AI – it can detect the matter but not the shapes. It's an area we're working on with a partner."

Aeroporti Di Roma attributes a great part of its success to its staff, who are all internal people. Additionally, the airport uses the QPass system, which enables passengers to book an appointment to go through Security Screening, and the GRASP sensor system, which directs passengers to the fastest SSL.

The Sectro solution reconfigures Security Screening, transformning it from a linear concept into a parallel process.

BOOKING AHEAD ENSURES QUICK, EASY ROUTE THROUGH SECURITY SCREENING

Frankfurt Airport has just launched its own booking system: FRA SmartWay.

It enables travellers flying from Terminals 1 and 2 to book a time for up to six passengers to navigate Security Screening.

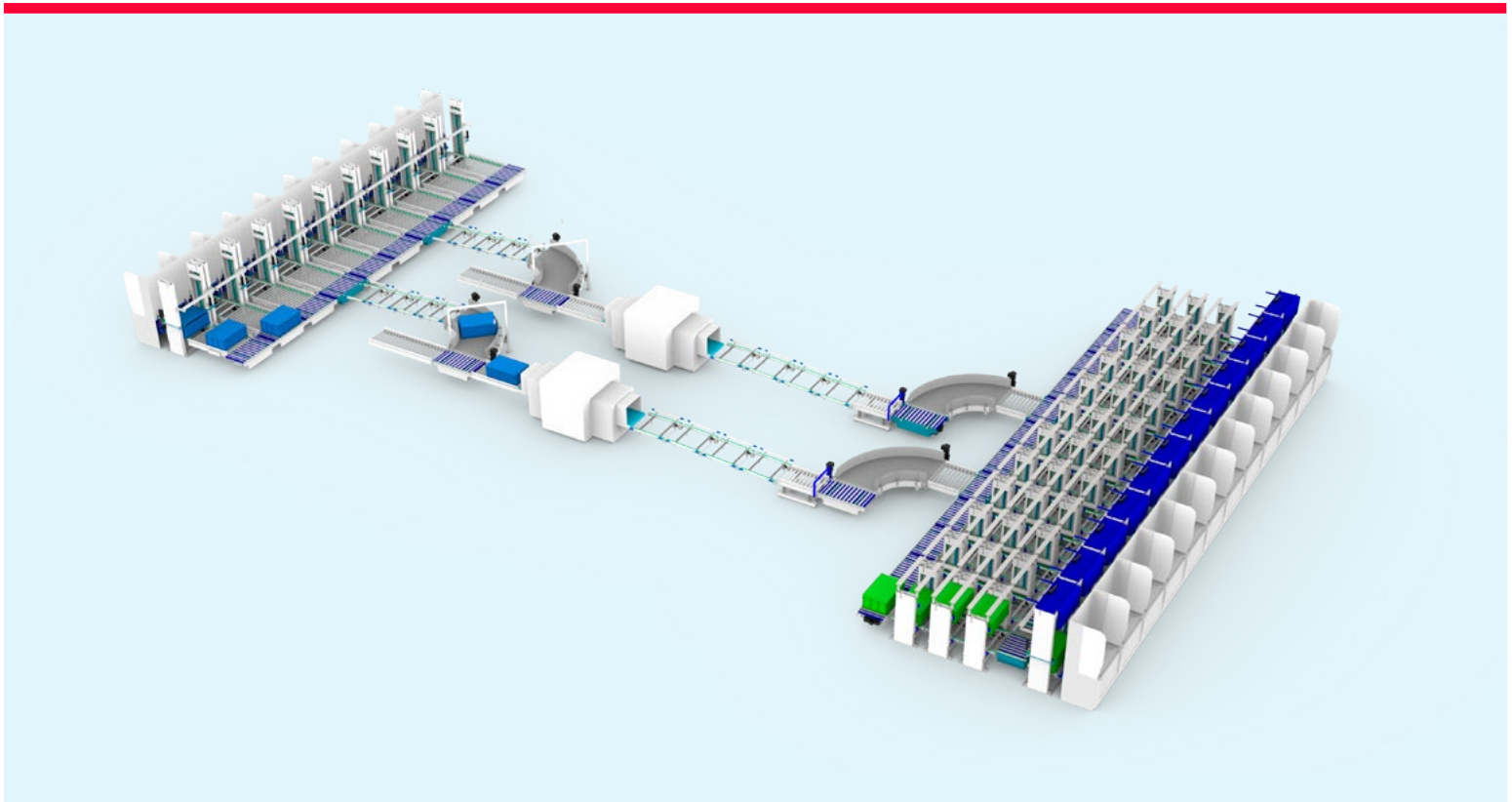
The service is free and does not require any online registration, so it can easily be booked on the way to the airport – the service is only available less than 72 hours before departure.

Sascha König, VP Infrastructure and Resource Management Terminal, explains that the system is specifically targeted at reducing the stress of flying:

“Our new FRA SmartWay service will help to provide a more relaxed airport experience for travellers … making the overall process faster and more predictable.”

Meanwhile, the airport’s operator plans to use the data obtained by the system “to manage passenger flows at our checkpoints more efficiently”.

Frankfurt joins a growing group of 16 airports that use Better Security, which was first adopted by Seattle Airport in late 2022.



Behind the scenes of the centralised system: the mechanics of the airport´s self-service security screening.

ULTIMATE SOLUTION: SOLVING ALL OF SECURITY'S PAIN POINTS

Certainly the systems used by the Better Security family and Aeroporti Di Roma are raising passenger satisfaction levels, but is there an alternative way to address all the pain points experienced in Security Screening – not just by the passengers, but airports too.

That’s why the industry is so excited about the pilot system Sectro, because it systematically addresses all Security Screening pain points, offering solutions that eradicate inefficient processes, save resources and alleviate passenger stress.

The Sectro system is a solution that completely simplifies Security Screening to take all the potential stress out of the equation, as very often passengers don’t know what’s required (shoes on or off, how many millilitres? etc), which causes confusion and anxiety.

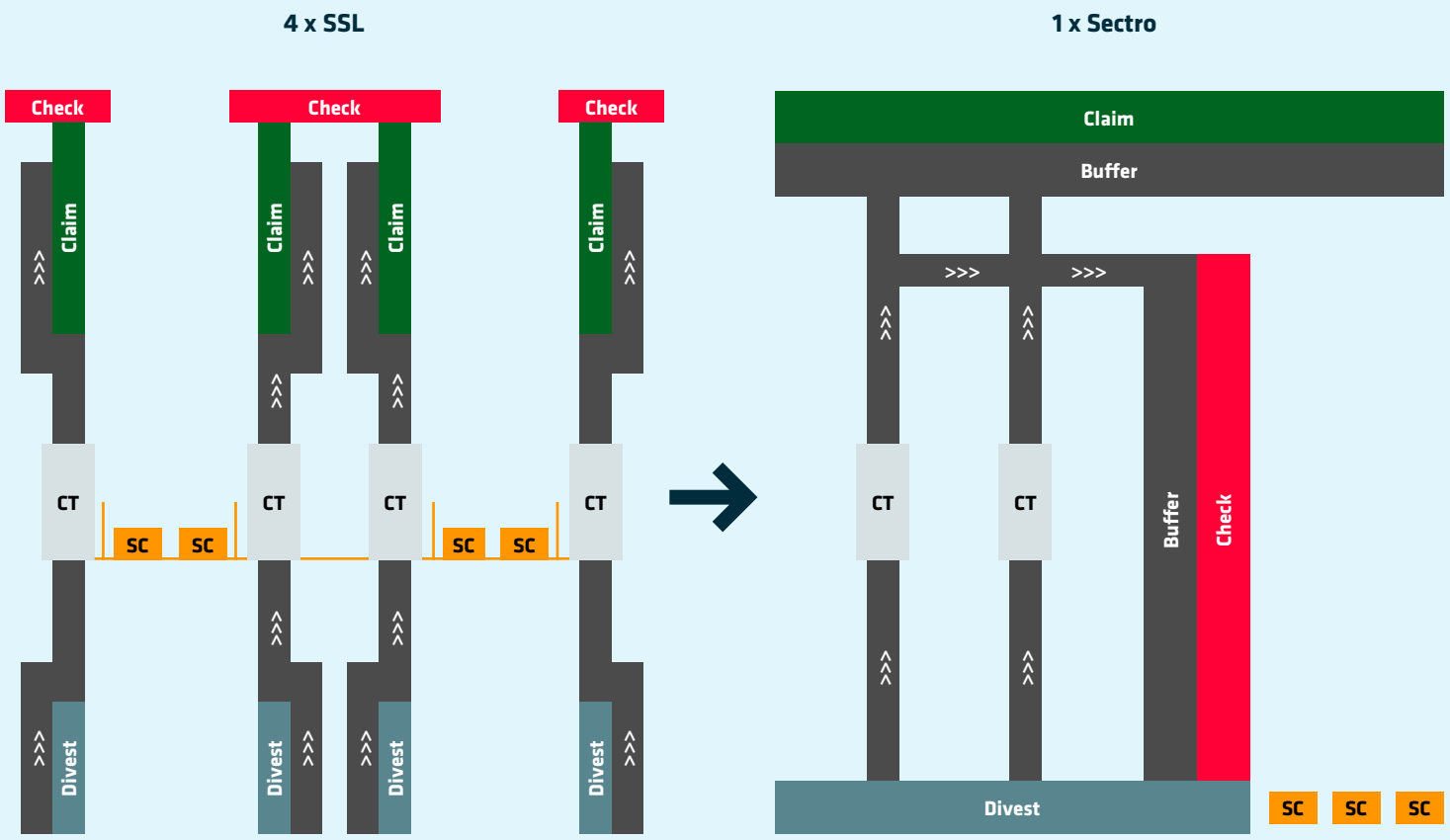
With the Sectro solution passengers simply follow three steps:

- Divest their belongings into a tray and have their photo taken (automated)
- Undergo a Passenger Check (manual)
- Head to either ReCheck for a further inspection (manual), or to automated ReClaim to collect their tray using their biometric ID (automated)

The Sectro experience starts with the passengers divesting all their belongings.

SECTRO BENEFITS FOR PASSENGERS INCLUDE:

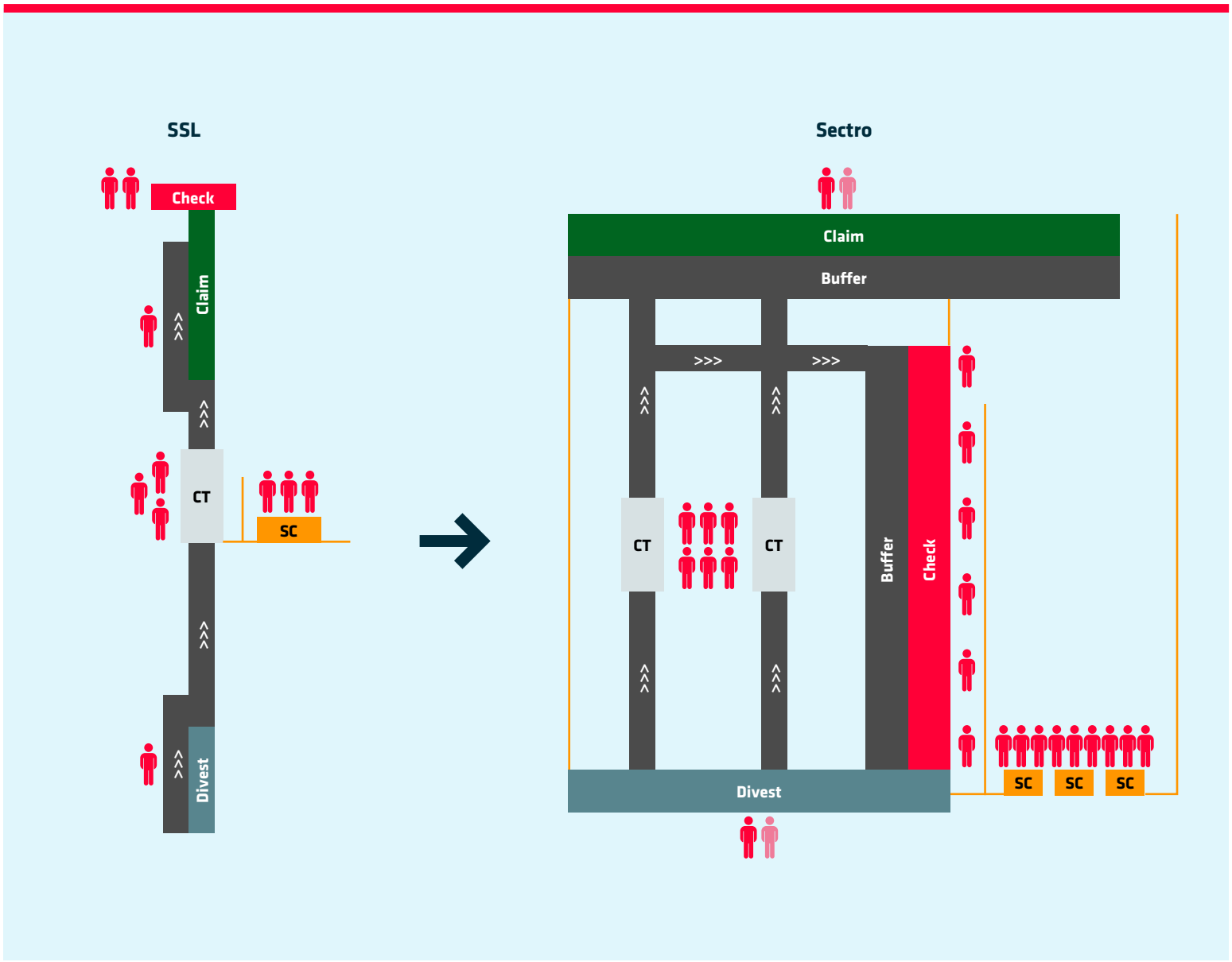
- **Shorter waiting times** – Sectro will reduce waiting times by 20-25 percent when the throughput is average, and by 8-10 percent during peak times. Part of this is achieved by reducing unpredictable incidents, pushback on the conveyor belt and bottle necks. It is also much easier to overtake slow passengers
- **No need for multiple trays** – the Sectro tray is longer and deeper, offering more than enough room to fit all possessions. It also has a lid for protection and extra security
- **No removal of liquids, laptops etc** – 3D scanning technology used by CT machines means passengers are no longer required to take any items out of their bags
- **Exposed possessions** – nothing stresses passengers out more than losing sight of their valuables. With the Sectro system, the tray enters the system and does not leave it until it's reunited with its owner. Track and trace technology ensures it does not get lost
- **Experience** – Security Screening can be ugly on the eye and taxing on the brain. Using automation to reconfigure the screening process (including passenger flow and terminal layout) will improve the passenger experience



Sectro utlisies the space of four SSLs to de-stress Security Screening.

SECTRO BENEFITS FOR AIRPORTS INCLUDE:

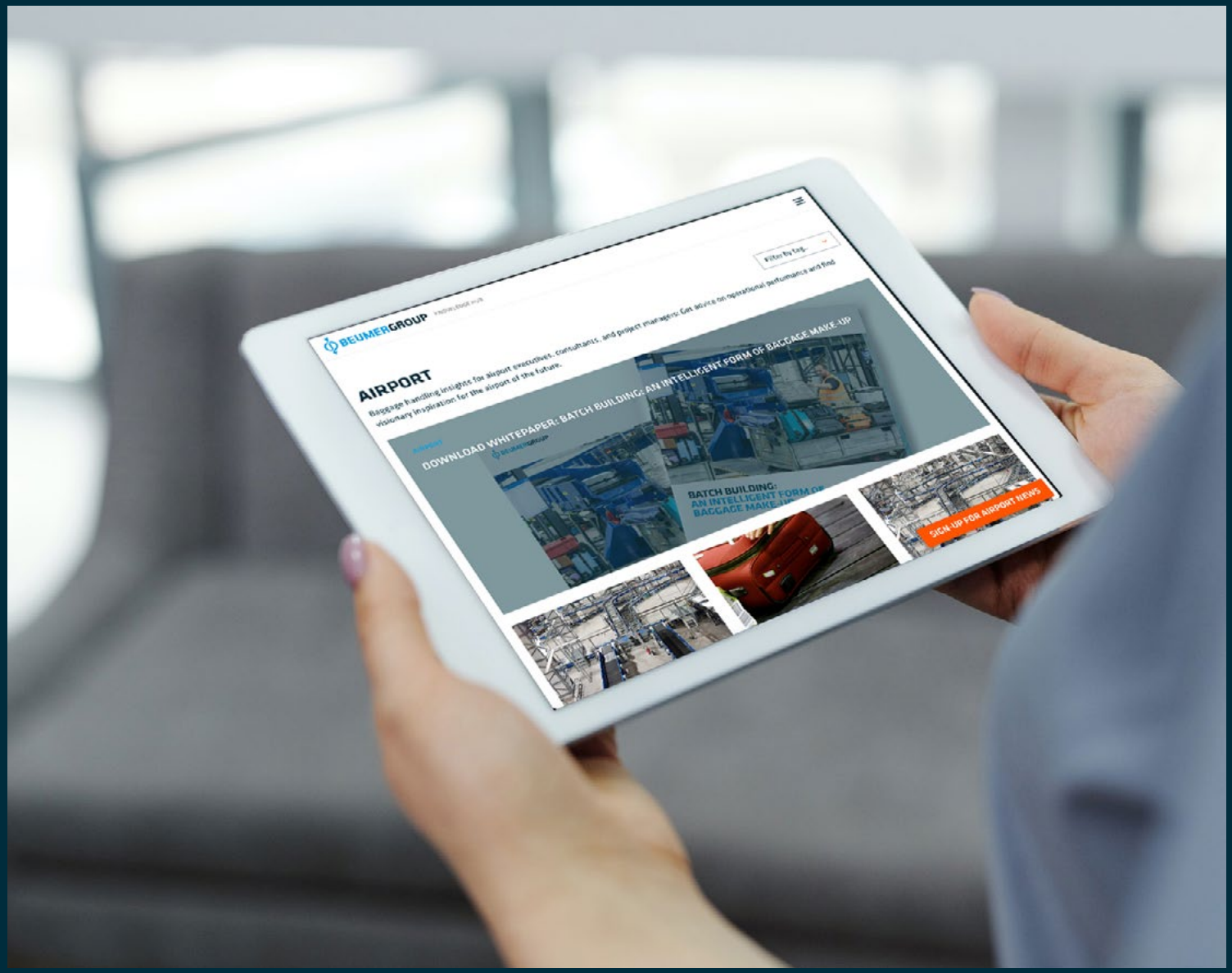
- **Centralised automation** – monitoring of CT scans is carried out in a centralised system
- **More efficient utilisation of resources** – using a Sectro system, the number of the costly CT machines can be cut by 50 percent. The system design will raise the machine utilisation rate, which is typically low
- **Inefficient use of staff** – for every four SSLs in use, airports will be able to cut their staff numbers down from 40 to 23-25, depending on the number of floor walkers (2-4 personnel deployed to help passengers struggling with technology). In general, Sectro reduces staff needs by 30 percent
- **Fewer trays** – airport will need fewer trays, which is a large cost saving
- **Reduced communication with passengers** – passengers are prone to getting annoyed when staff ask them abruptly whether their bag contains liquids/laptop, or tell them to remove their shoes etc
- **More efficient use of terminal space** – Sectro unit replaces four SSLs to create an attractive screening area
- **Automated return of trays** – staff will no longer need to manually collect trays, as the system will automatically return them to divesting area
- **Cost** – the Sectro solution can deliver major operational efficiencies for airport operators, who can expect to cut an airport's Security Screening area's OPEX by 30-40 percent



Sectro greatly reduces the required number of Security Screening staff.

SECTRO BY FAR THE QUICKEST DURING PEAK PERIODS:

- With the Sectro solution, passengers could conceivably arrive at Security Screening and find only a few waiting, enabling them to pass through security screening in approximately three minutes.
- The solution can almost guarantee passengers a total duration of no more than four minutes, regardless of how many are passing through, making passengers confident they will catch their flight.
- The size of a Sectro system will depend on the number of SSLs it is replacing and a Sectro system can be expanded to replace any number of lanes. This means airports using the Sectro system will be able to centralise their automation.



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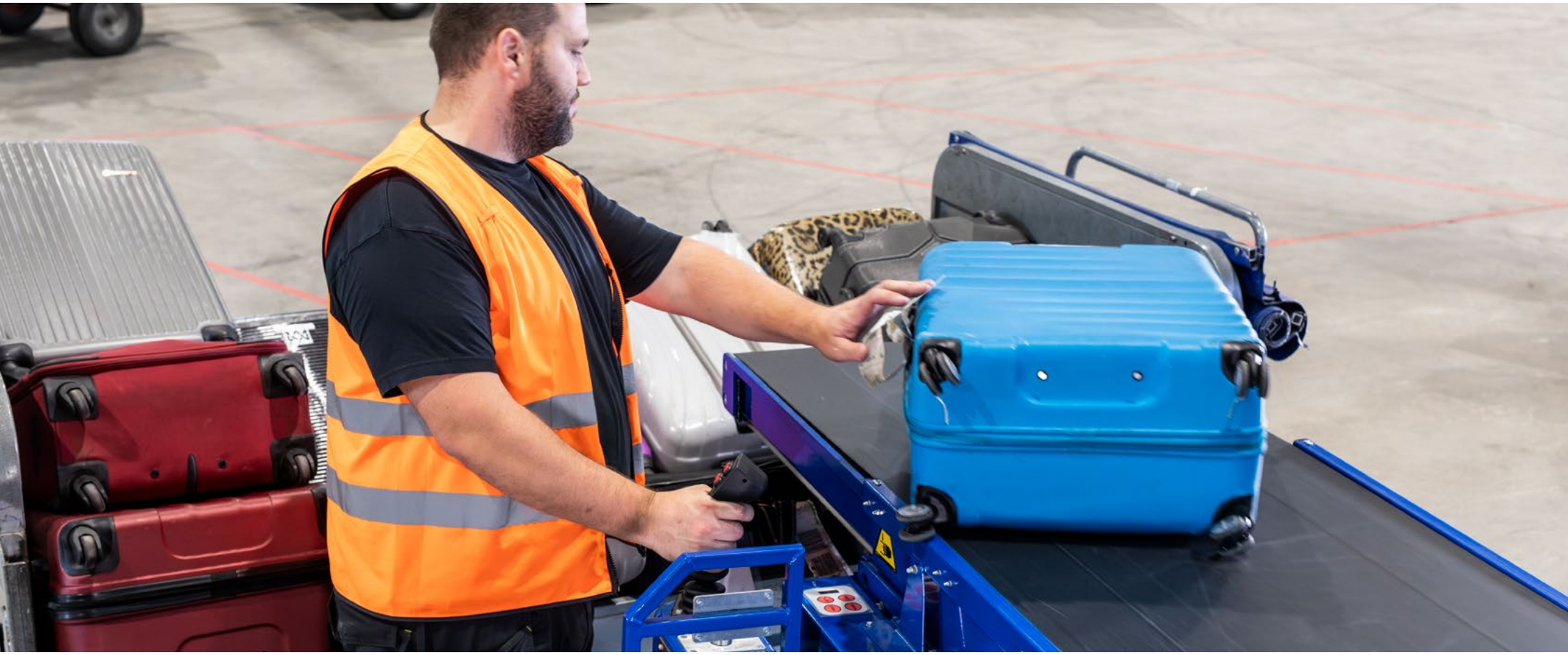


CHAPTER 2:
GREEN LIGHT FOR BHS PROVIDERS TO AUTOMATE GROUND HANDLING

The demand for labour-saving processes inside the airport is not going away, as staff shortages continue to be a problem.

Airports have responded well in recent years, with many moving quickly to automate where they can: most particularly in regards to the handling of baggage in both the Check-In and the Baggage Handling System (BHS).

Chapter 1 demonstrated how airports now have the chance to automate Security Screening, and Chapter 2 will move outside the terminal to look at how ground handling systems, struggling with their own staff shortages, also require effective automation.

Given that this area of the airport starts at the very point the automated BHS ends and ground handling operations take over, it makes sense to refer to the area as the ground handling system – as was the case in this recent report.

HELPING GROUND HANDLING SYSTEMS TO ALLEVIATE LABOUR SHORTAGES

In recent years, the role of baggage handlers in the ground handling system has come under sharp focus due to labour shortages: it takes a lot of people and equipment to run baggage-related ground handling operations.

The area is overseen by ground handling operators employed by the airport or airlines to load and unload the aircrafts, and increasingly the operators are looking at the savings achieved inside the airport and asking BHS providers to help them.

BHS operators, given their experience in providing such solutions, are accordingly taking an interest in an area they previously had limited incentive to get involved in.

The automation makes sense, as ground handling is expensive. Not only does it account for about 8 percent of an airline's operating expenses – but also the lion's share of the baggage handling cost: as much as 50 percent.

THE TECH WITH THE POTENTIAL TO AUTOMATE GROUND HANDLING

The room for improvement in the ground handling system is vast: called in to assist, BHS providers can see many of its processes can be performed in a different and more efficient way.

These include the final sorting of the baggage in the make-up area, loading the baggage onto the trolleys or unit load devices (ULD), and then automatically transporting baggage to a handover point outside, from where it will be loaded to the aircraft.

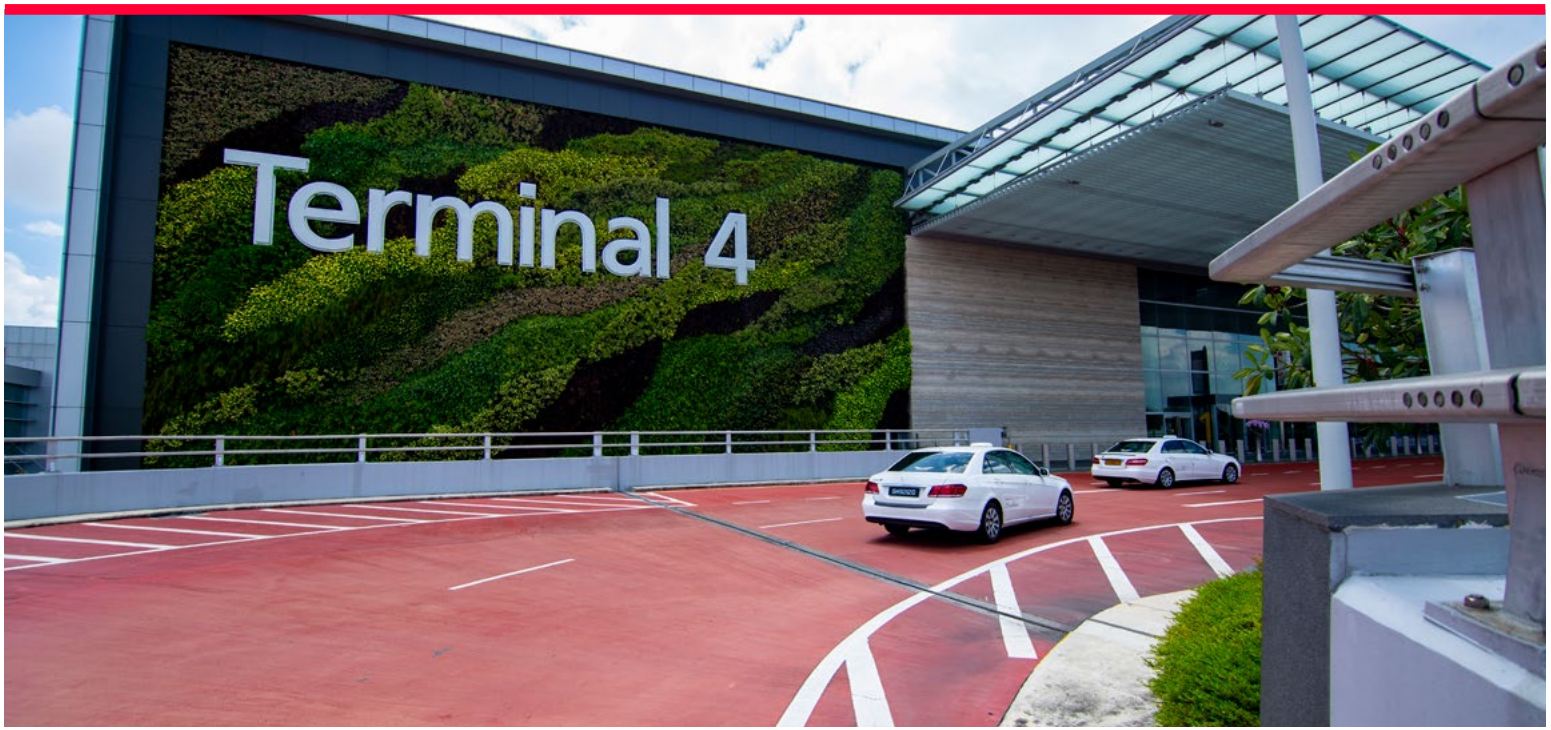
Automation innovations would make it easier for ground handling operations with limited labour resources to improve the process between the BHS and ground handling system.

However, investment in the necessary technology is lacking, even though ground handling would become more efficient at a time when there are labour shortages and airports would pay less for a more efficient service.

So which technologies will automate the ground handling system?

Batch building and automated handling of ULDs will help automate ground handling in the future.

- **Robotic or other automatic/semi automatic loading** – the machinery exists but it's not as good as a human loader, who is able to place luggage depending on size and weight. Robot loaders tend to fill containers that are structurally unsound
- **AGVs (automated guided vehicles)** – trials of the driverless vehicles have been ongoing for several years. However, there are question marks about how they fare in bad weather conditions, such as heavy rain or when it's been snowing
- **Batch building** – optimal when used together with an ICS, as it will help automate the ground handling operation by filling the ULDs more efficiently



Changi Airport in Singapore.

WHY ROBOTIC LOADING NEEDS TO SEE THE BIGGER PICTURE

While most airports know and some already use semi-automated loading processes to put baggage into ULDs, there have been question marks about how seamless robotic loading is.

The robotic loading replaces a human operator using automation with a robot, but the processes before and after the robotic handling have been overlooked with little regard for the bigger picture.

But now that BHS providers are onboard with innovating the area, they might be able to extend the last process of the BHS to enable a more seamless integration with the first step of the ground handling system.
BHS operators will need to address how the human operator at the bottom of the chute was performing an important sortation role that the robot can't replicate at the same speed.

The robot is unable to quickly distinguish between light and heavy bags, thus slowing down the process of filling containers that are structurally sound (heavy bags at the bottom, light at the top etc).

Automation is only effective if it replaces a human operator and betters their performance, so this is definitely an area that BHS providers will be seeking to improve.

AGV TECHNOLOGY KEY TO AUTOMATING TRANSPORT OF BAGGAGE TO AIRCRAFT

Using in-built sensors, machine learning algorithms and real-time data analytics, autonomous vihicles are capable of transporting baggage between the terminal and the aircraft. The aviation world is awaiting the results of several ongoing trials.

At Changi Airport in Singapore, its operator has been testing a driverless baggage transfer 'tractor', the TractEasy EZTow. They have a ULD carrying capability and can operate in tight spaces thanks to the ability to move sideways and rotate within its own length. Meanwhile, bi-directional robotic arms enable it to load itself.

Narita International Airport in Japan is also testing the TractEasy EZTow tractors – an initiative that has the backing of the country's Ministry of Land, Infrastructure, Transport and Tourism – as are Dallas Fort Worth International Airport, Schiphol Airport in Amsterdam, Toulouse Blagnac Airport and Oslo.

Trials of another autonomous vehicle, the

Autonom Tract AT135, are ongoing at Frankfurt Airport, Charles de Gaulle and Toulouse.

And finally, Cincinnati/North Kentucky International Airport is testing self-driving vehicles to transport luggage. Autonomous vehicle technology from a company specialising in automated ground handling technology has been added to regular vehicles.

BATCH BUILDING: HOW BHS PROVIDERS HAVE ALREADY MADE A START

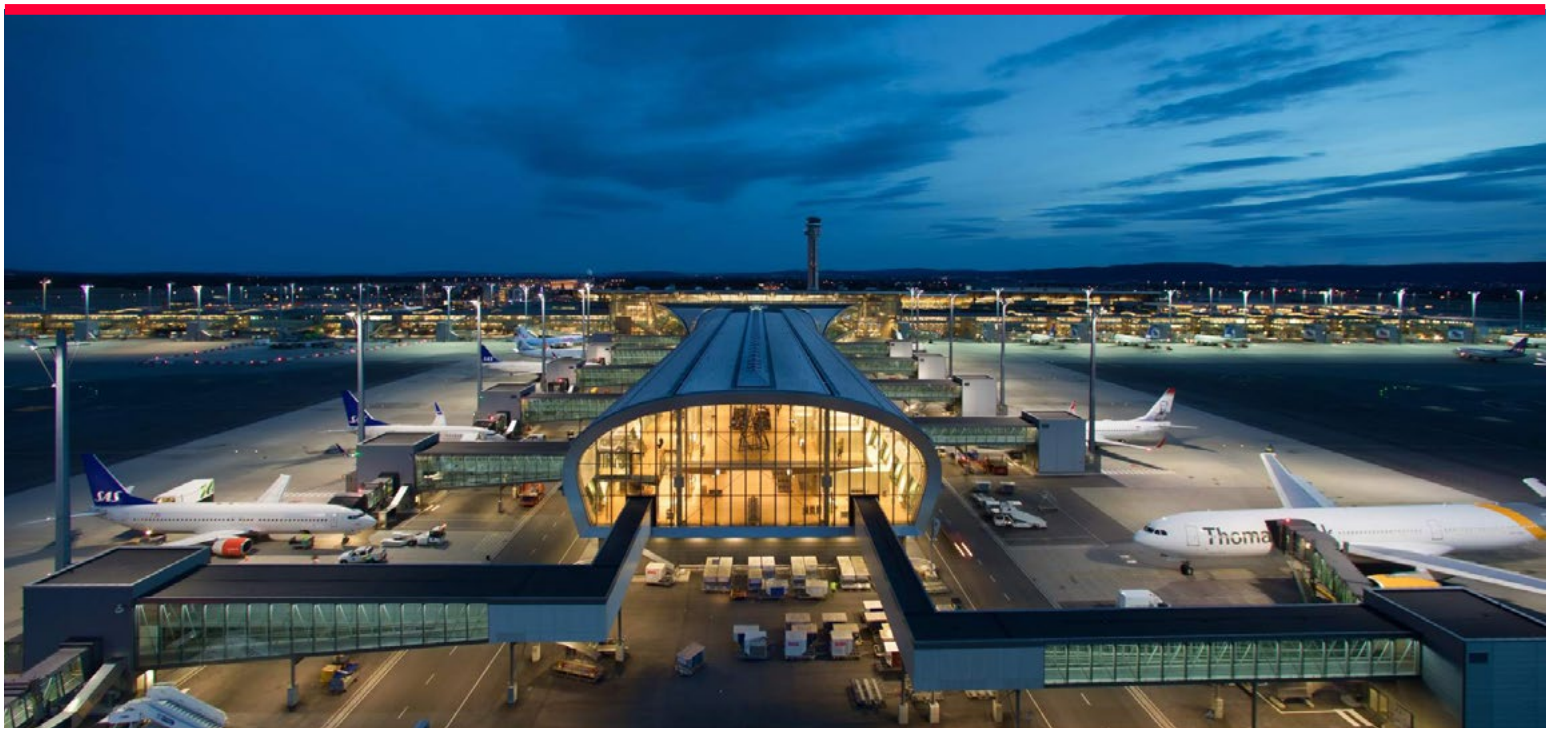
Batch building has already enabled BHS providers to make inroads into the ground handling system and optimise baggage make-up.

Instead of baggage leaving the chute and entering the ground handling process, it is first diverted to a dynamic baggage storage, thus remaining in the domain of the BHS.

The batch building principle enables baggage handling operators to produce flight builds as needed and on demand – for example, based on specific criteria.

Used in conjunction with modern BHS technology, batch building utilises the least-attractive real estate in airport terminals for dynamic storage and reduces the overall space needed in the make-up area.

The automation used by batch building is a perfect fit for airports with staff shortages. It will reduce the OPEX and optimise the baggage handling system footprint.



Oslo Airport in Norway.

ALL EYES ON OSLO AIRPORT LATER THIS YEAR

Probably the most significant deal yet signed in the emerging sector was an innovation partnership (IP) agreed by Avinor, the operator of Norway's major airports, to explore ways of automating the ground handling system.

Innovative solutions will be trialled in a live environment at Oslo Airport, where Avinor has built a dedicated project test centre, for three months from September 2024.

The overall aim of the IP is to:

- Increase the efficiency of the baggage handling process
- Remove repetitive heavy lifting duties undertaken by baggage handlers
- Automate end-to-end baggage handling processes

PASSENGER BENEFITS: FEWER MISHANDLED BAGGAGE INCIDENTS

An added bonus of automating ground handling systems is eliminating human error from the baggage's journey to the aircraft.

Up until the point where the BHS ends and the ground handling system starts, airports using modern ICS-based BHS technology have guaranteed that the baggage's journey has been fully tracked and traced through Security Screening and sortation – with a success rate of more than 99.9 percent.

At such an airport, the most likely area where baggage will be mishandled is in the ground handling system: between the BHS and the

aircraft, and then between the aircraft and the carousel upon arrival.

Mishandled luggage rates soared over the first three years of the decade to as high as eight bags in every thousand, but that number fell in 2023 – back to a level last seen in 2019.

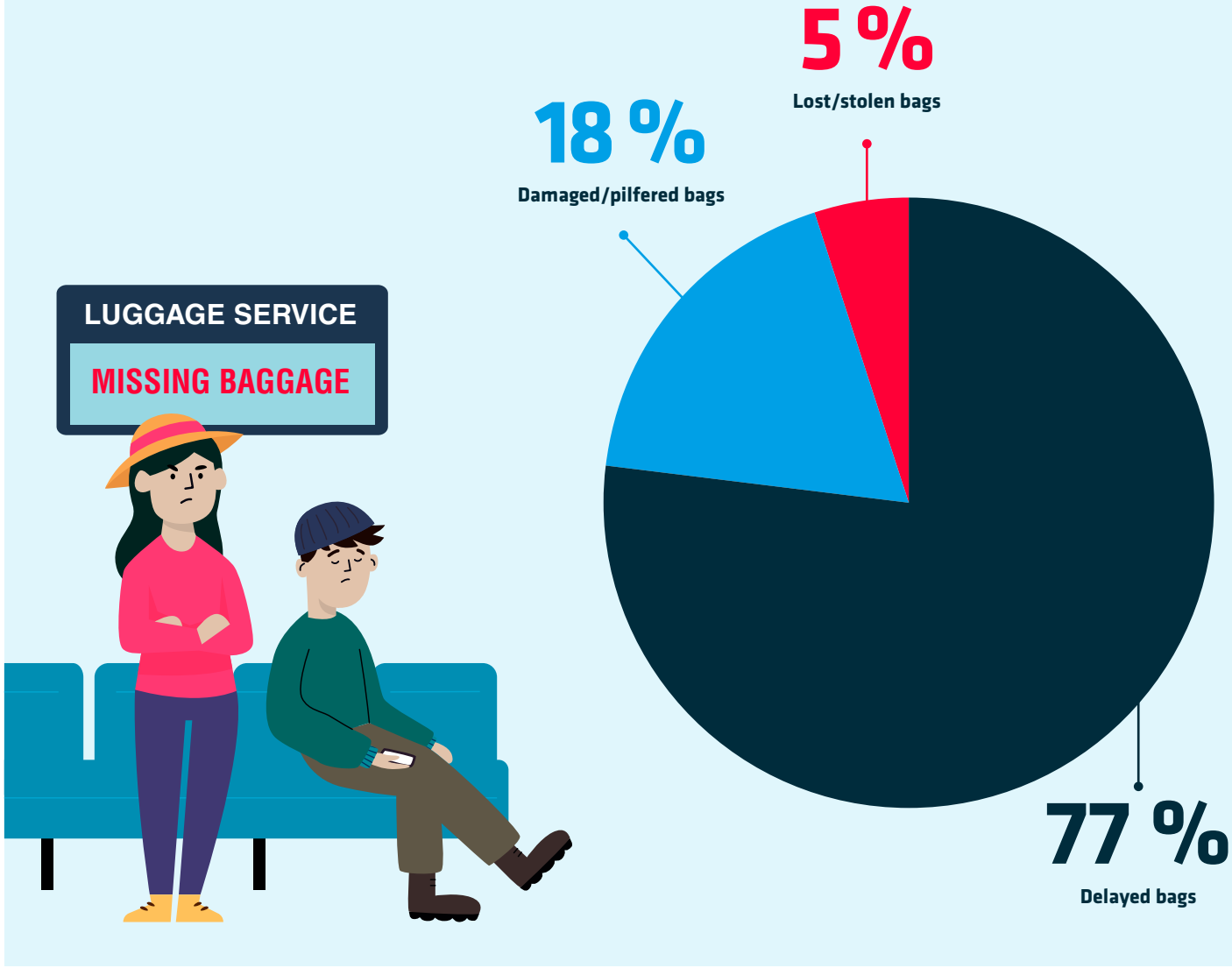
Nevertheless, the industry is confident the use of automation and biometrics can reduce the rate further in the future: to the point that lost luggage is an anomaly.

EXTRA PERKS TO IMPROVE THE PASSENGER EXPERIENCE

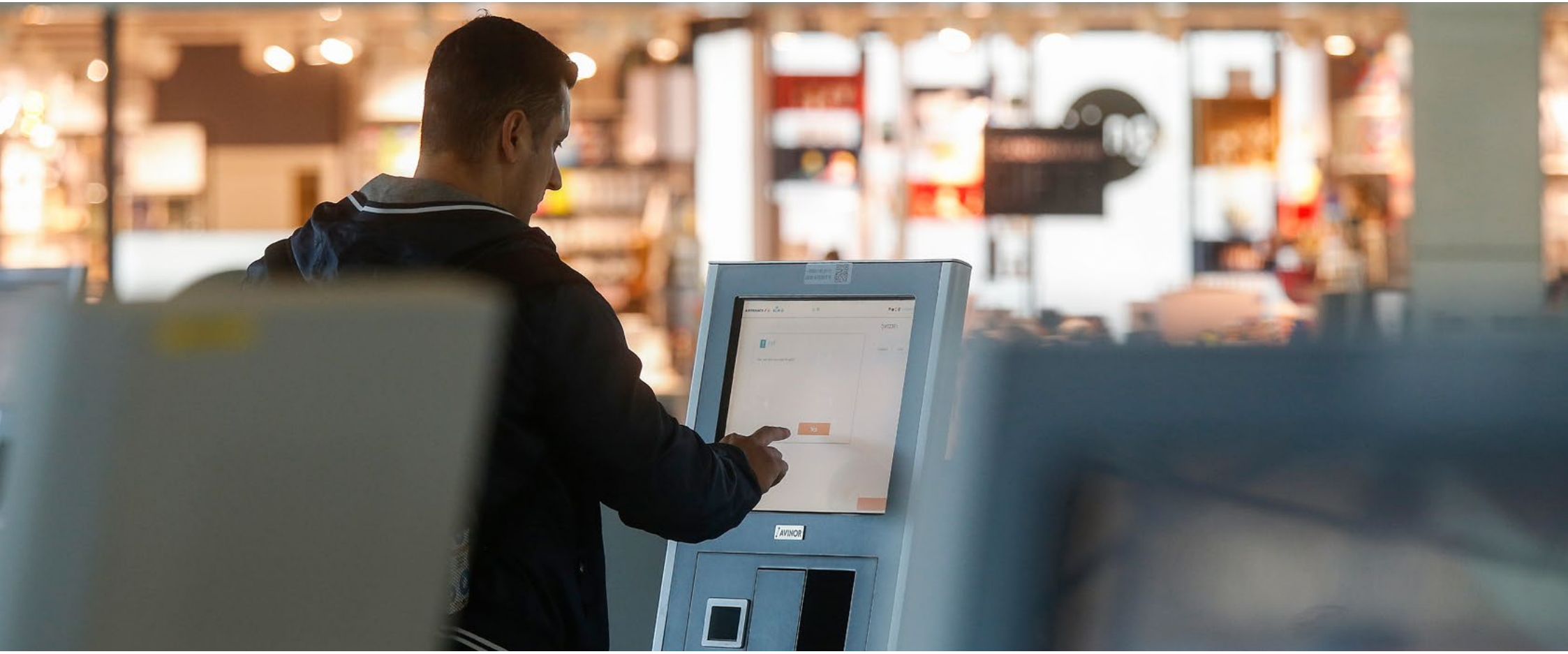
Increased automation in the ground handling system will further improve the passenger experience for a number of reasons:

- **Reduced lost luggage incidents** – elimination of human error will see a huge reduction in the mishandled baggage rate. Meanwhile, track and trace technology can ensure safe delivery to the aircraft
- **Early check-in** – Dynamic baggage storage will enable early check-in of baggage – for example, the day before an early departure. This service will likely appeal to travellers staying at hotels near airport
- **Reclaim on demand** – Dynamic baggage storage at arrivals airport enables passengers to pick up their baggage at their leisure, free of the stress of crowded reclaim areas and possibility of baggage being picked up by somebody else. Alerted by an in-app message, they pick up baggage at a Reclaim on Demand kiosk where they access their bag using a QR code

Lost luggage rates



Source: 2024 SITA Baggage IT Insights.



CHAPTER 3:

DIGITAL PEACE OF MIND: HOW ROBUST CYBERSECURITY CAN EASE PASSENGERS

Not only do passengers want to feel safe in the stratosphere, but also in the digital sphere. They submit sensitive data when they fly, so the least the airports and airlines can do is ensure their data is well protected. Failure to do so risks losing the passengers' trust.

Chapters 1 and 2 have highlighted how airports that invest in the automation of their Security and ground handling system can further optimise the efficiency of their processes and improve the passenger experience.

Automating manual processes, at a time when many airports are struggling to attract labour, is very much an investment in the 'now' that bodes well for future performance.

But to fully thrive in the future, airports also need to invest, and continue investing, in their digitalisation, so it is no surprise to note that across all regions, upgrading legacy technologies and systems is a commercial priority for 92 percent of airport leaders.

The airports ahead of the technological curve also keep ahead of potential threats to their cybersecurity – and the well-being of their passengers – and they all tend to have one thing in common: the recruitment of a trusted software supplier, from conception through to the end of the life-cycle.

TSA AMENDMENT A POTENTIAL GAME-CHANGER FOR AIRPORT SECURITY

Consider an airport and the many different IT systems in play – overseeing information for passengers, airlines, BHS systems and operators and ground services – and imagine the pain points of them not being properly managed and maintained, or coordinated with airlines.

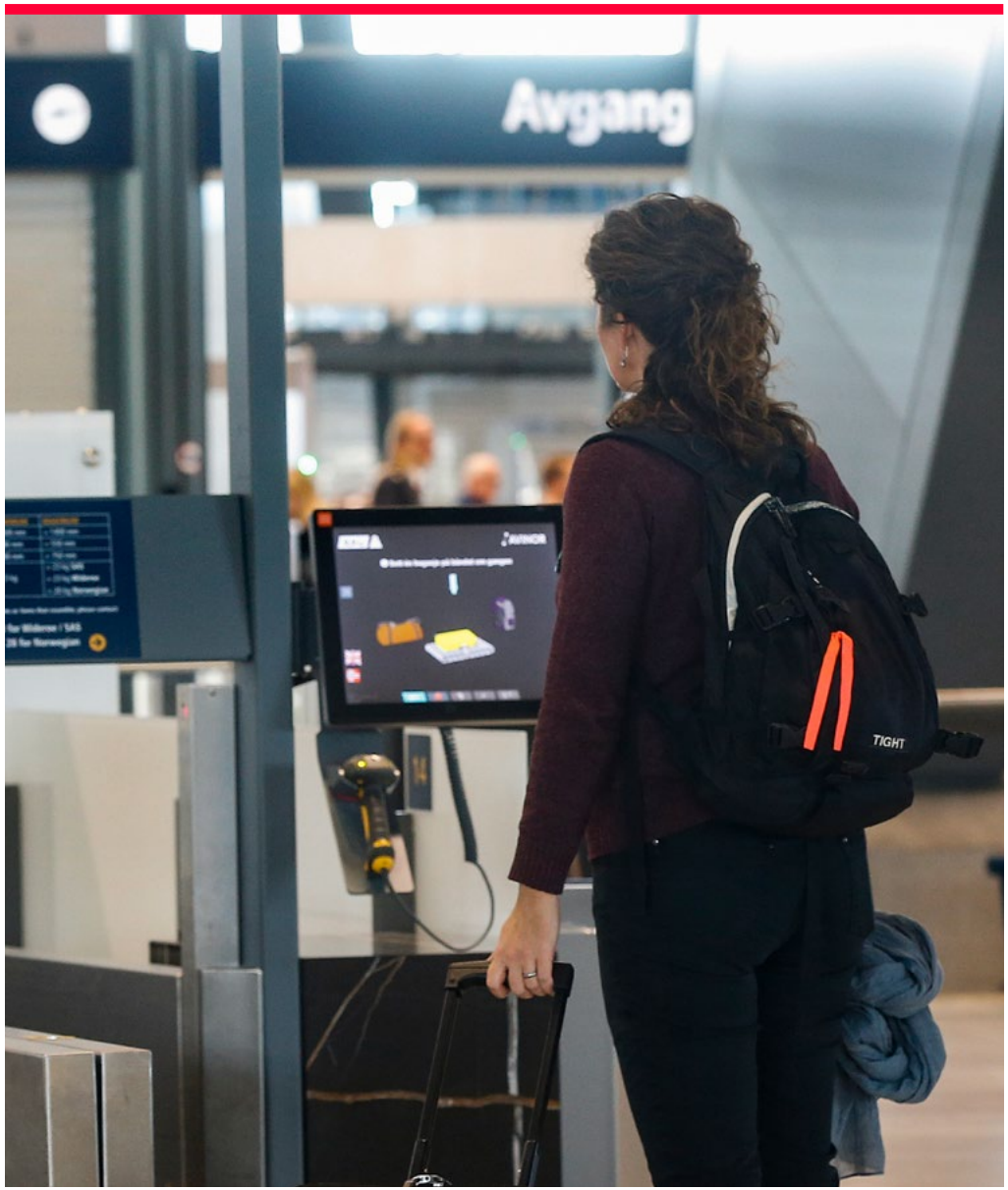
So it was encouraging to note the amendment released last year by the US federal transport body, the Transportation Security Administration (TSA), which could very well prove to be a worldwide game-changer for airports seeking to optimise their digital sphere.

In total, the TSA's amendment identified four key objectives:

- Develop network segmentation policies and controls to ensure operational technology systems can continue to safely operate in the event that an IT system has been compromised, and vice versa
- Create access control measures to secure and prevent unauthorised access to critical cyber systems
- Implement continuous monitoring and detection policies and procedures to defend against, detect and respond to cyber-security threats and anomalies that affect critical cyber system operations
- Reduce the risk of exploitation of unpatched systems through the application of security patches and updates for operating systems, applications, drivers and firmware on critical cyber systems in a timely manner using a risk-based methodology

This has many benefits for airports, and it enables:

- A more unified and standardised approach to security equipment and software frameworks that embrace agile, flexible



Investing in digitalisation is a priority for most airports.

technological advancements
- Enhanced interoperability between different security systems – international and intercontinental
- Increased ease to make upgrades and add new functions
- The use of established 'off the shelf' OEM equipment and hardware/software, which is open source or freely licensed, allowing asset owners to choose from a wide range of components for their systems
- Improved resilience to cybersecurity threats

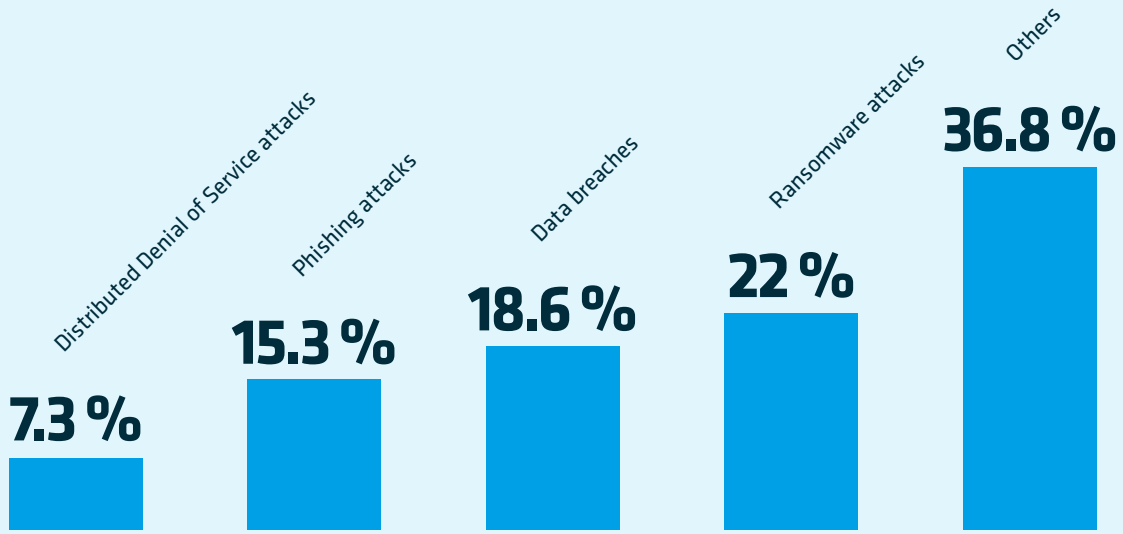
The latter can be achieved by adhering to IEC 62443 standards that protect systems over the course of their entire life-cycle: from design and development to deployment and maintenance.

CYBER-SECURITY PROS AND CONS SERVED UP BY THE DIGITAL AGE

A cyber-attack accesses sensitive information – related to passengers, cargoes and schedules – to disrupt flights, causing financial losses and harm to an airport's reputation and aviation in general. Passenger trust is further eroded if their own personal data is breached: after all, how gladly will they entrust the airport or airline with their biometrics, if the data falls into the wrong hands?

Airports face a tougher challenge than ever in this digital age, as there are a vast number of ways cyber-criminals can attack – including phishing, malware, ransomware and denial of service (DoS) attacks – and a growing number of devices and systems to target, which are all interconnected and a potential way in.

Most common types of post-Pandemic cyber-attacks on airports



Source: www.eurocontrol.int

The same technological advancements seen in the realm of AI could feasibly be destructive in the wrong hands – and there is additional concern about the AI malfunctioning.

An airport's cybersecurity infrastructure needs to be increasingly robust and efficient to see off cyber-threats.

Training staff to follow protocols is a high priority, as is investment in the latest operational technology, from Internet of Things (IoT) devices to biometrics, to oversee processes such as BHS, passenger flow and facility management.

In truth, seeing off the threat of cyber-security is a herculean task that no airport can ever fully accomplish. It's vital airports continue investing in it, but even those who spend insane amount of money will know they will have to continue digging into their pockets, again and again, as new threats emerge.

But it's important they see the bigger picture and regard every investment in terms of its life-cycle. And this is much easier when the technology is recommended, provided and serviced by a trusted software supplier.

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CHAPTER 4:

SUSTAINABLE FOCUS: HOW AIRPORTS ARE RESPONDING TO ESG CONCERNS

Some passengers will always have concerns, regardless of the level of service.

For the majority, though, travel can be a care-free experience if they're confident they and their luggage will arrive safely at the destination. However, another concern is growing and it's no longer a fad: passengers (and the wider public) want to know that aviation is prioritising ESG responsibility heading into the future.

Pollution will continue to be a problem as long as the airlines continue to use jet fuel, and converting the aircraft over to green alternatives, such as sustainable aviation fuel (SAF) or hydrogen power, will take several decades and a lot of innovation.

In the meantime, it is encouraging to see many airlines are upgrading their fleets with fuel-efficient aircrafts as part of their commitment to achieving net-zero emissions by 2050.

WHY ESG PLANS ARE THE NEW BLACK

So it is mostly left to airports to signal to passengers they are taking ESG matters seriously.

The result is that ESG plans are the new black. Airports are accordingly changing their strategies to mitigate their impact, reduce carbon emissions and promote eco-acceptable practices throughout their operations.

But are passengers – who are concerned about their own ecological footprint but still keen to fly – warming to airports and airlines with outlooks that prioritise ESG concerns?

Chapter 1 of this report concluded that not investing in the passenger experience might not noticeably reduce the numbers of people using an airport, but does result in reduced revenue in the Departure Hall.

Similarly, it's unlikely that not investing in your ESG standards will reduce the numbers of people using an airport, but it will make your airport significantly greener at a time when the environment needs all the help it can get.

Airports are accordingly investing in three key areas:

- ESG infrastructure
- ESG programs
- Electric ground transportation

MODERN AIRPORTS TREAT THEIR BUILDINGS LIKE THEY'RE TEMPLES

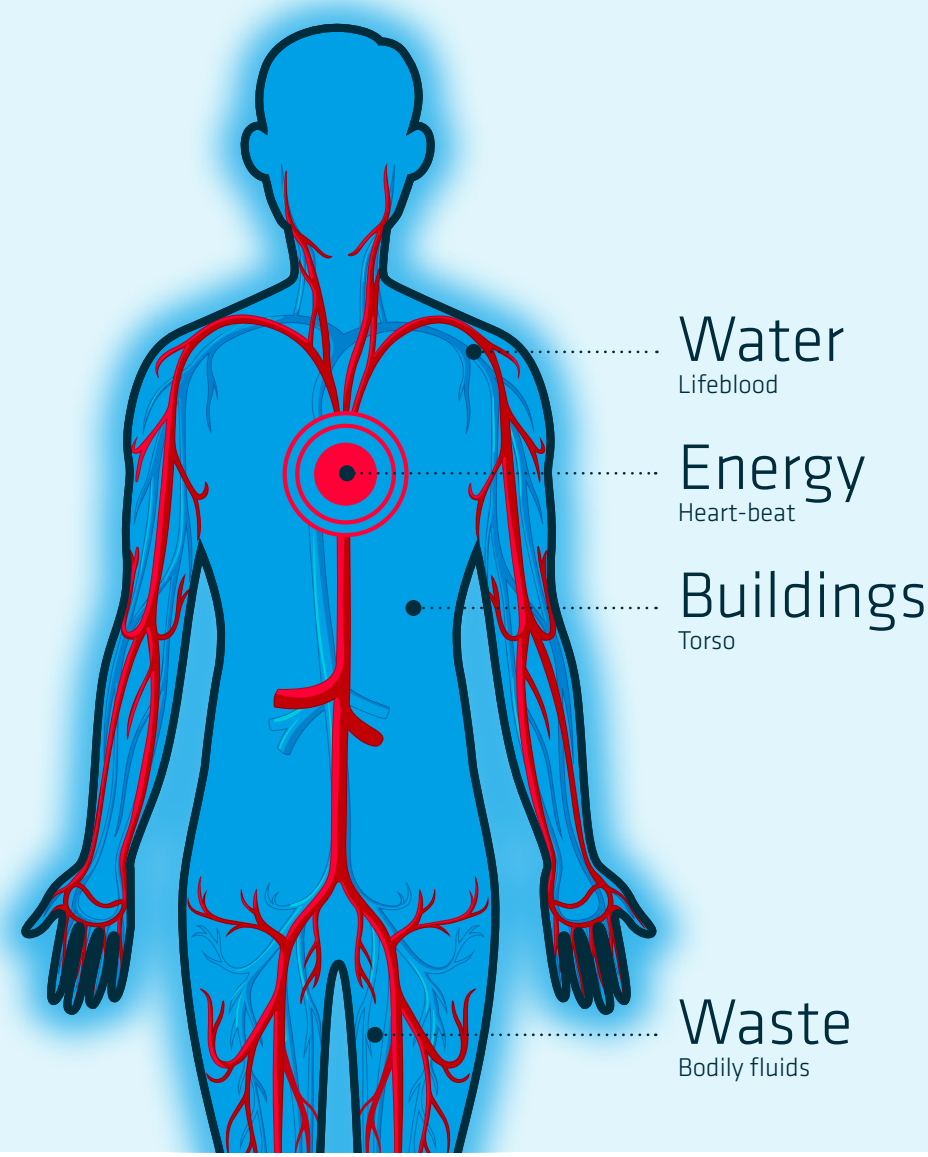
Think of a modern airport as you might regard the human body and you'll see ESG responsibility oozing out of every pore.

The construction (the torso) is built according to green building standards that prioritise energy efficiency, water savings, CO2 emission reductions, improved indoor environmental quality and the stewardship of resources.

The energy (the heart-beat) is derived from renewable energy sources, including solar panels on the roof, wind turbines and geothermal heating facilities.

The water (the lifeblood) is managed and conserved to the highest standards. From rainwater harvesting systems to advanced

If the airport was a human body ...



wastewater treatment facilities, onsite water is reclaimed, recycled and reused.

And finally the waste (the bodily fluids) is reduced and then recycled or reused.

Many airports are already onboard, including:

- **Cochin, India** – the world's first fully solar-powered airport has 46,000 panels spread across 45 acres. Not only does the solar plant take care of the airport's needs, but it is a contributor to the state grid, making Cochin a net producer
- **Oslo, Norway** – has a geothermal energy system that utilises underground heat to provide heating and cooling for its terminals. It hasn't quite achieved carbon-neutrality, which explains why it's installed solar panels
- **Munich, Germany** – as well as solar panels, it derives its energy from biomass heating plants. Furthermore, it has significantly reduced its consumption by implementing energy-saving technologies in its buildings and infrastructure

PROGRAMMED TO SUCCEED: TAKING CUES FROM LEADERSHIP IN DESIGN

ESG responsibility in the airport sector is not a new concern, as many airports have been adhering to sustainability programs for nearly three decades.

Perhaps the best known program – the Leadership in Energy and Environmental Design (LEED) certification, which provides a framework for healthy, highly-efficient and cost-saving green buildings to mitigate their ecological footprint by using renewable energy and reducing emissions and energy consumption – was founded in 1998 by the US Green Building Council as an inspiration for American cities and communities. Today LEED has grown to become the world's most widely used green building rating system.

Programs like LEED played a role in informing EU legislation – such as the Renewable Energy Directive, the Energy Efficiency Directive and the EU Emissions Trading System – to follow over the following decade, drawing further attention to ERG concerns.

Other programs include construction sustainability assessment method BREEAM, which was founded in 1990, and the Airport Carbon Accreditation initiative, which has certified 563 airports in 86 different countries making efforts to manage and reduce their emissions.

Among the airports embracing programs are:

- **San Francisco, US** – has achieved LEED Platinum certification, the program's highest rating (see more in Chapter 5)
- **Schiphol Amsterdam, Netherlands** – has achieved LEED Gold certification for several of its buildings thanks to the implementation of extensive recycling programs and sustainable water management systems that align with EU directives. It's on course to be zero-waste by 2030
- **Heathrow, UK** – its Terminal 2 has been awarded a BREEAM Excellent rating in recognition of its sustainable design and construction – again heavily

The greenification of airports can be literal too.

influenced by EU directives. Heathrow has implemented energy-efficient technologies and extensive recycling programs to make it carbon-neutral by 2030

- **Munich, Germany** – has received several LEED certifications, including a Gold rating for its satellite terminal. It has also achieved Level 3+ Neutrality as part of the Airport Carbon Accreditation program
- **Oslo, Norway** – its Terminal 2 has been awarded a BREEAM Excellent rating in recognition of its sustainable construction and energy efficiency. In line with the EU's focus on energy efficiency and renewable energy use, it has embraced extensive waste reduction programs to achieve carbon-neutrality

GREEN HUE OF ALL NEW TRANSPORT – AT THE AIRPORT AND BEYOND

Given the tendency of airports to grow ever larger, it increasingly makes sense to provide electric train or bus shuttle services, sourcing their energy from renewables such as solar or wind power, to transport airport visitors to carparks, between terminals and to aircraft parked on the perimeter of the airport.

Additionally, there is the matter of transporting luggage: firstly through the airport building via an automated baggage handling system, of which providers of modern BHS systems are forever working hard to further reduce its energy consumption. And then secondly from the baggage make-up and ground handling system to the departing aircraft, for which electric, hybrid and self-automated dollies have become popular for baggage, ground handling and maintenance purposes.

And last but not least, the airport can promote sustainable transport outside the domain of the airport, either with the installation of charging stations in its carparks to encourage passengers to use green vehicles to drive to the airport, or by investing in the regional rail network.

Among the airports embracing sustainable transport are:

- **Changi, Singapore** – uses electric tractors for baggage handling, which are powered by an extensive network of charging stations
- **Brisbane, Australia** – currently involved in testing autonomous electric vehicles for shuttle services
- **San Francisco, US** – its comprehensive Clean Vehicle Policy promotes the use of alternative fuels and electric vehicles within the airport's fleet
- **Stockholm Arlanda, Sweden** – has incorporated biofuel-powered buses to ferry passengers to aircraft
- **Central Communication Port, Poland** – significant ESG upgrades earmarked for regional rail services ahead of airport's 2032 opening. It has already earned the nickname 'Solidarity Transport Hub'

It's not by chance that San Francisco Airport makes so many of these lists, as it is one of the world's best examples of LEED excellence, for which it has been certified platinum.

Onboard with the 17 Global Goals for Sustainable Development.

So where better to go to conclude this report than the airport that has set the highest possible standards.

Find out more in Chapter 5.

CHAPTER 5:

HOW THE LEED DESIGN BUILD APPROACH HELPED SFO TO GO PLATINUM

Three years on from San Francisco International Airport (SFO) opening the most expensive building in its 97-year history, has its new terminal fulfilled its quest for excellence?

Certainly, the platinum certification bestowed on Harvey Milk Terminal 1 by the LEED program, which has helped form its Integrated Project Delivery approach to human environments and technological innovation, suggests it has surpassed all expectations.

But beyond going platinum and ticking boxes, what's the feeling on the ground?

To learn more, the BEUMER Group Airport Report caught up with Kristin Allen, the Program Manager of the ongoing Reconstruction Program at SFO, which is responsible for the redevelopment and future maintenance of three terminals.

In this interview, Kristin discloses how the LEED design build approach enabled SFO to strive for the highest standards across the board.
"The design build team helped us to understand the latest and greatest in the industry."

THE LEED DESIGN BUILD APPROACH: THE BEST OF EVERYTHING

Many airport operators planning a new building tend to fix their design before key stakeholders, such as the baggage handling system providers, are recruited. This means the airports often have to settle for a one-size-fits-all solution.

But the LEED design build approach advocates an approach in which the design is not finalised until all the stakeholders have contributed ideas, and this helicopter perspective enabled SFO to take everything into account, enthused Kristin:

"Our stakeholders clarified their needs and wants: what works, what doesn't, what's 100 percent necessary, and what's nice to have."

In this pursuit of excellence in everything, SFO is not necessarily reinventing the wheel, reasoned Kristin, but setting the highest possible standards in everything it does:

"I don't know if any one particular thing we do is unique. Rather it's the cumulative effect of everything we do."

GATHERING THE RIGHT PEOPLE TOGETHER FROM THE ONSET

A comprehensive stakeholder engagement approach was in place at the very beginning of the program for Harvey Milk Terminal 1, for which planning began in 2014 and the first phase initiated in 2019.

Instead of being set goals by the management, the goals were co-created by the team, a process that made them feel fully invested but required them to feel comfortable expressing themselves: explained Kristin:

"This is a people business and we're all people, so we wanted to help and motivate the stakeholders to be and do the best they can. In a pressurised situation, people don't always get it right, and things aren't always perfect,

Kristin Allen, the Program Manager of the ongoing Reconstruction Program at SFO.

"We set high standards for ourselves that we then want to eclipse with each project moving forward."

Kristin Allen, the Program Manager of the ongoing Reconstruction Program at SFO

but giving the team space to try new things, in a forgiving environment, played a big part. People feel safer; they feel more comfortable."

The program "gathered the right people together" from the very onset, set clear expectations and cultivated a shared, committed approach to problem solving:

"We started with the right mindset: a culture that promotes trust and collaboration to make participants comfortable with being innovative and exploring new ideas."

Every stakeholder could be certain this was no ordinary program: standards would be higher than they had ever encountered before:

"The result was a great collaboration between our designers and the builders, vendors and manufacturers. To enable this, we gave our team free rein to express themselves. They knew new ideas might inspire other ideas, and that even if we can't afford it today, the ideas could be set aside to be re-explored – possibly on future projects."

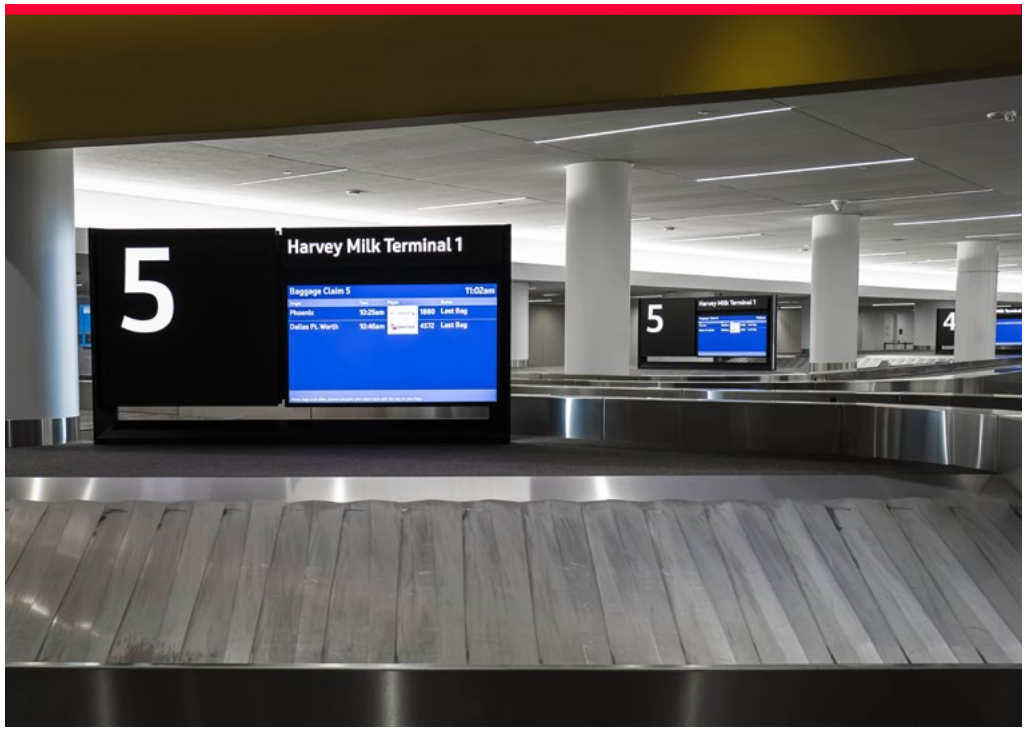
STRINGENT 'BASIS FOR IMPLEMENTATION' REQUIREMENTS

Each collaboration with a vendor or manufacturer began with a clear outline of the requirements of the building – in line with standards that earned the new terminal the prestigious Fitwell 'Best in Building Health® 2021', the first time the award has been given to an airport building:

"So no bridging documents, no design efforts. Instead, we asked them to put together a team, show up, take part in our programming. After five to nine months – depending on the complexity of the project, which might involve a lot more detailed requirements being added to the project – we would have what we call a 'basis for implementation'."

This included a base of design, a project delivery plan, cost model and assessment of criteria fulfilment relating to innovative building technologies, security and sustainability.

For example, life-cycle analyses of all building materials – from the ceiling tiles down to the carpet, assessing embodied carbon etc – were carried out, along with cost assessments.



Nobody waits long for their baggage at Harvey Milk Terminal 1.

And the airport's energy sources was also a major discussion point – geothermal power was even considered as a possibility – as was every step of the passenger experience.

PRIORITISING THE PASSENGER EXPERIENCE EVERY STEP OF THEIR JOURNEY

So not only were safety and comfort key components in their approach to planning, but also in the program's approach to the passenger experience, noted Kristin:

"We consider all their journey moments in the airport: from the curbside all the way through check-in, checkpoints and waiting rooms and then arriving. And it is their comfort level in these moments that are considered in all aspects of the building architecture – the intuitive wayfinding of the building."

The results of comfortable passengers is well know to the industry, explained Kristin:

"It's fantastic when passengers aren't standing around for 20 minutes waiting for their bag to show up."

Kristin Allen, the Program Manager of the ongoing Reconstruction Program at SFO

"If passengers are more comfortable – they know where they're going and how to get there – they're going to spend more money at your restaurants and your stores, which then allows us to do even bigger and better things next time."

Likewise, from the outset of the program, every member of the design build team has known where they're going and what the overall goals are.

Each is fully onboard with the goals outlined in SFO's REACH (Revenue Enhancement and Customer Hospitality) guide – an exploration of the key journey moments and the program's expectations of what passengers should experience in the airport's spaces.

ESG GAINS INTERTWINED WITH PASSENGER EXPERIENCE GOALS

The passenger experience of the airport's spaces goes hand-in-hand with the program's sustainability and healthy buildings goals. An excellent example of this synergy, pointed out Kristin, can be observed in the boarding area, where the dynamic glazing of the windows ensures passengers are never blinded by sunshine, uncomfortably warm nor unable to either see information screens or the "great views" outside:

"This also reduces your HVAC needs because you're keeping the heat gain down [the energy consumption is a third of what's used by similar terminals], while the cumulative effect of the glazed windows, filtration system and construction materials ensure the air quality is high."

And the benefits of the healthy building extend beyond the passenger experience because they also enhance working conditions in the airport – again underlining how the program's approach is not just orientated around the passenger experience, but the whole people experience, contends Kristin:

"The whole airport is happy – and this extends to the staff."

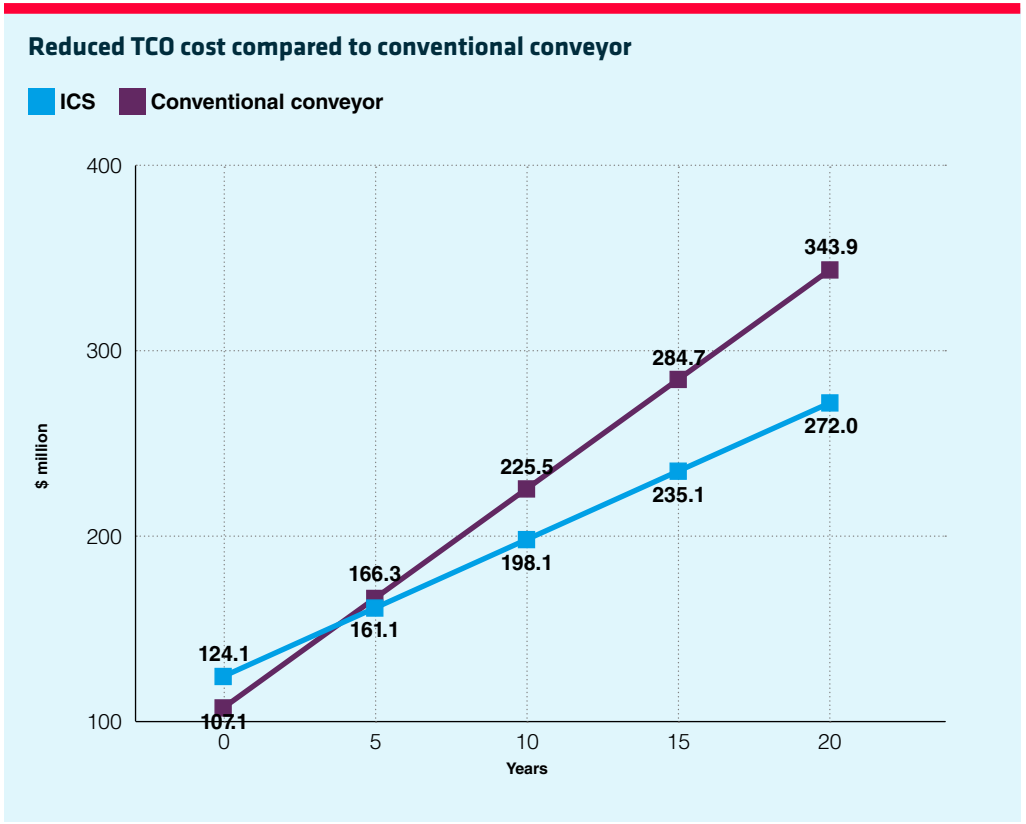
THE WISDOM OF INVOLVING A BHS PROVIDER FROM THE START

For evidence of how happy the passengers are, you only have to go to baggage claim, enthused Kristin, because most will discover their luggage waiting for them:

"It's fantastic when passengers aren't standing around for 20 minutes waiting for their bag to show up. In fact, I haven't heard of an issue with lost bags."

The choice of Independent Carrier System installed by SFO to handle its baggage, which according to Kristin has "functioned very well", was based on a number of factors, including passenger experience, reliability, predictability, maintenance costs and operating costs (see graphic).

Notably, it has fewer staff requirements, a smaller spare part inventory ("because it's so standardised"), and heavily reduced energy



Source: BEUMER Group Conceptual Design Report for SFO, 2016.

usage because the belts “only run when they need to run”.

Kristin cannot overstate how critical it is to procure a baggage handling subcontractor early in the process.

“They need to be there when the programming is done for the overall building. You need to understand what sort of space needs there are. If we had moved forward with the building without having them there, we would have had some really big challenges going forward.”

In the end, only a minimal number of adjustments needed to be made to the building to accommodate the BHS because the planning was so diligent.

Although costly, they were a tiny fraction of what it would have cost to incorporate a baggage system into an airport with a fixed design before the appointment of the BHS provider, revealed Kirsten:

“We spent maybe $100,000 moving just a one-inch conduit here or there, and a couple of other little things: a couple of structural hangers were in the wrong spot. But that’s great coordination, as far as I'm concerned, regarding such a massive system in a building.”

It's never been a question of SFO competing with other airports. For benchmarks it looks within.

PLATINUM-CERTIFIED AIRPORT A GREAT EXAMPLE OF DESIGN BUILD EXCELLENCE

Overall, SFO has hit every single one of its milestone dates whilst staying on budget, but it’s never been a question of competing with other airports, more competing with itself:

“We set high standards for ourselves that we then want to eclipse with each project moving forward.”

As one of the few LEED platinum buildings in the world, its Harvey Milk Terminal 1 continues to be revered in the industry as one of the world's best examples of design build excellence.

Batch building: An intelligent form of baggage make-up

Airports have spent decades refining baggage handling systems (BHS) and operations. But what about baggage make-up? How can this overlooked and often ineffective part of baggage handling be improved to increase efficiency?

Want to learn more?
Download the white paper

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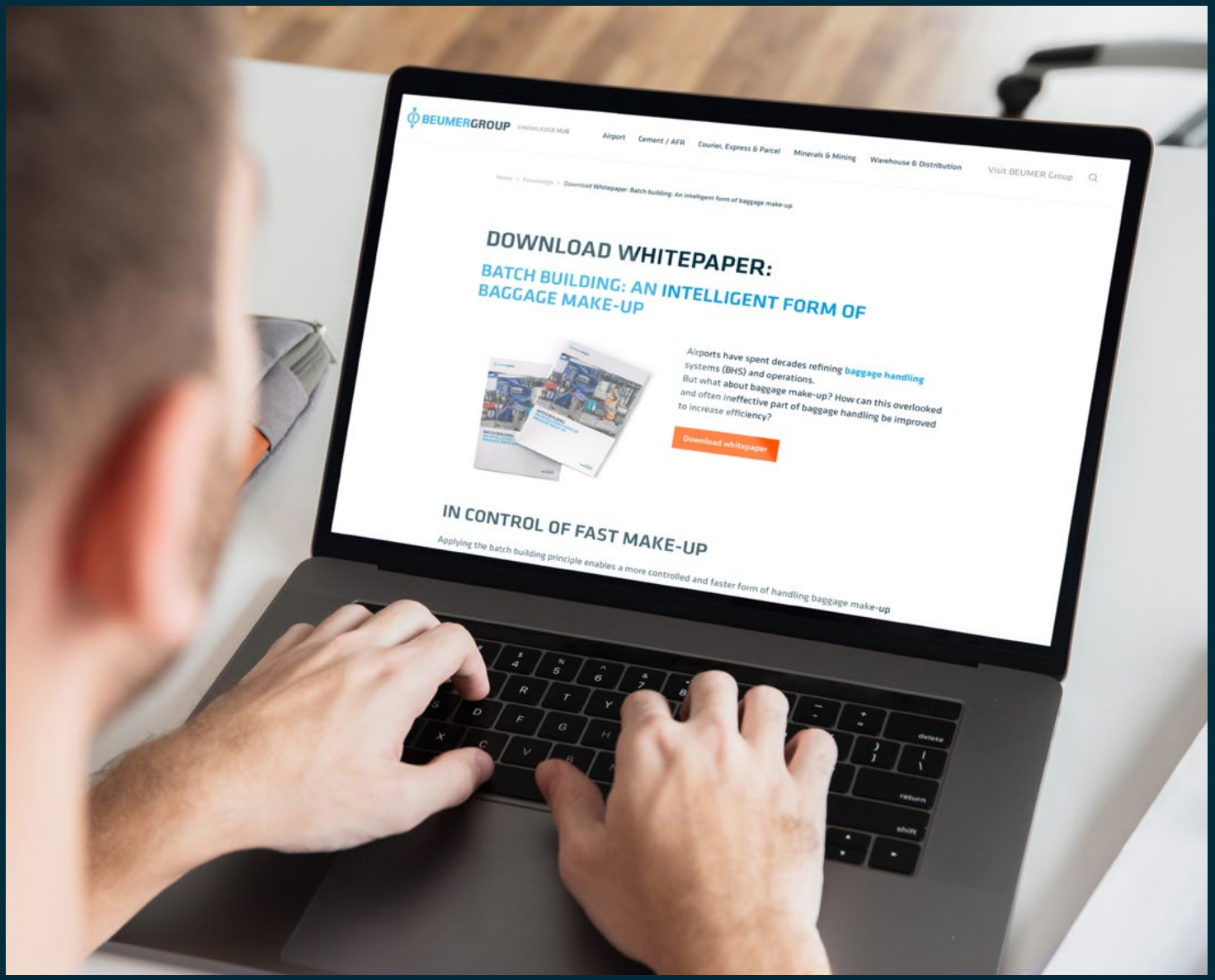

CONCLUSION

Inside the pages of this report, we have learned how the industry is further optimising both airport processes and the passenger experience to radically change the way we fly. And it has given us some interesting takeaways.

The ongoing demand for labour-saving processes in airports, driven by persistent staff shortages, has led to significant advancements in automation.

Many airports have effectively automated their baggage handling, and the next natural step will be the Security Screening process and parts of the ground handling operations.

Innovating these processes can help reduce operational expenses further and optimise efficiency. The integration of robotic solutions will make airport operations more resilient and cost-effective in the face of labour constraints.

So it is encouraging to observe the ongoing efforts to automate Security Screening and ground handling operations.

Both are good news for passengers – particularly Security Screening, the biggest cause of stress among passengers during their departure.

The impending arrival of new Security Screening solution Sectro promises to have a huge impact in this respect, as most passengers will pass through in a good mood, which will make them more predisposed to spending money in the Departure Hall.

But it's more than a collective happy pill. It optimises the flow of passengers and it addresses how centralised automation and digitalisation technologies can solve recurring challenges regarding bottlenecks, delays and staffing levels. And as an added bonus, the automation is tidily hidden from the passengers' view – like it is with baggage handling. Airports are fast discovering that removing all causes of stress is a recipe for success. And while providing comfort in their buildings remains a popular approach, increasing numbers are investing in ESG measures.

Most passengers know flying leaves a large carbon footprint, but they feel better about getting onboard aircraft if they know the industry is doing everything it can to lessen the environmental impact. And airports are fast discovering that every ESG measure counts: from constructing green buildings to offsetting emissions.

Ensuring passenger safety in the digital sphere remains crucial. Airports must invest in cybersecurity and digital upgrades to protect sensitive data and maintain trust.

Again, automation and modern technology can help enhance efficiency and security. Continuous investment in these areas is – and remains - essential for future resilience against cyber threats.

All of this underlines how important the passenger experience is to airports heading towards 2025 in what is always turning out to be a recordbreaking year for the industry. And the standards are only going to be set higher and higher.

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