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Rethinking People Flow

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Insights into Airport People Flow – A Research Perspective

The benefits of integrating loudspeaker messaging and people counting to manage people flow

Key insights

This whitepaper is based on research at Berlin Brandenburg Airport (BER), which explored the synergistic use of two technologies: a Passenger Flow Management System (PFMS) and an Automatic Announcement System (AAS).[1] The PFMS is a system that tracks passengers, providing real-time anonymous data on passenger flow and density. The AAS delivers targeted, automated loudspeaker announcements.

Coupling AAS announcements with real-time data from the PFMS significantly improved passenger flow at BER. Targeted announcements effectively redistributed passenger traffic between security checkpoints, leading to more balanced and efficient use of their security control resources.

9.57%

decrease
in Wait Times

The findings showed a noticeable reduction in waiting times, predicted waiting times, and queue lengths, especially when looking at long-term data. In the short-term analysis, the decrease in predicted waiting times and queue lengths showed that the use cases and announcements did affect how passengers moved through the airport. The study also made sure to consider the rate at which passengers were processed (outflow) and the number of security lines open. This was to confirm that the improvements were actually due to the use cases and announcements, and not because more lines were open or people were processed faster.

Introduction

Airports worldwide, especially in areas like check-in and security, often face the challenge of long queues and waiting times. The magnitude of this challenge is increasing, as evidenced by global statistics. According to the Airports Council International, 2024 is expected to mark a significant milestone, reaching 9.4 billion passengers, surpassing pre-COVID-19 pandemic levels.[2] This places much pressure on airport operations, making the findings of this study crucial for those responsible for ensuring smooth airport experiences.

Escalating congestion and operational complexities underscore a critical need for efficient people flow management. Congestion obviously affects passenger experience negatively, but there are other consequences: The study cites research that shows that an additional ten minutes spent at security control can reduce passenger spending in airport retail by up to 30%.[3] Additionally, 33% of passengers surveyed were unaware of announcements made in the preceding ten minutes, suggesting that broad, non-specific announcements often go unnoticed,[4] and that targeted and timely announcements are crucial for effective passenger flow management and ensuring that critical information is communicated efficiently.

The insights gained from the research at BER offer valuable lessons for airports globally, demonstrating the effectiveness of technology-driven strategies in addressing the complex challenges of modern air travel. Professionals such as Heads of Terminal Operations, Chief Operating Officers of Passenger Experience, CIOs, and Airport Technical Leads, who grapple with these challenges daily, will find it particularly helpful.

The Berlin Brandenburg Airport (BER) Study

Context

The study on optimizing passenger flow through the integration of the PFMS and the AAS was conducted against a backdrop of specific local conditions, a defined test period, and clear use cases, focusing on key performance indicators (KPIs).

BER, like many post-COVID-19 airports, faced challenges of increased passenger volumes coupled with labor shortages, leading to significant congestion, particularly at check-in and security areas. The airport's infrastructure, especially in terms of space limits, added another layer of complexity to efficiently managing passenger flow.

BER has two main terminals, T1 and T2, with five security controls across them. Most gate areas are accessible through all security control checkpoints. The focus of the study was on the three security controls that did not employ a virtual queuing system and so did not allow passengers to reserve slots in advance. Each security control has eight security lines, but with noticeable differences in throughput, ranging between 40 and 130 passengers per hour per line. This difference is largely due to the spatial layout and the more modern facilities at T2's security control. For passengers moving between these controls, the distances and walking times vary between 10 minutes and 15 minutes, depending on whether the connection between them is airside or landside.

Research overview

Objective and KPIs

The objective of the BER research was to determine whether the combined use of the Passenger Flow Management System (PFMS) and the Automatic Announcement System (AAS) could effectively reduce waiting times and manage queues at security checkpoints, a critical area in airport operations. The overarching aim was to optimize the distribution of passengers across the available security controls, thereby reducing waiting times and queue lengths effectively.

A series of tests were conducted at three security controls within BER to assess the impact of this integrated approach. The evaluation involved analyzing changes in waiting times, queue lengths, and outflow using statistical methods, with the aim of providing practical solutions to improve passenger flow and overall airport efficiency.

The German and English announcements were similar to this example: "Dear guests, please also use security control 5 because of shorter waiting times."

Announcements were triggered when data from PFMS revealed these predefined conditions:

- Use case 1: Redirecting passengers from Terminal 1 Security Control 1 to Terminal 1 Security Control 5 when the Predicted Waiting Time (PWT) at T1 SC1 was equal to or greater than 20 minutes, and the difference in PWT between T1 SC1 and T1 SC5 was more than 10 minutes.
- Use case 2: Redirecting passengers from Terminal 1 Security Control 5 (T1 SC5) to Terminal 1 Security Control 1 (T1 SC1). The trigger conditions were similar to use case 1, with the roles of T1 SC1 and T1 SC5 reversed.
- Use case 3: Redirecting passengers from Terminal 1 Security Control 1 (T1 SC1) to Terminal 2 Security Control 1 (T2 SC1) when the PWT at T1 SC1 exceeded 35 minutes, the PWT at T2 SC1 was less than 25 minutes, and the PWT at T1 SC5 was also above 35 minutes.

The PFMS provided real-time data, enabling the assessment of how effectively the AAS announcements influenced passenger distribution and movement. Effectiveness was evaluated using several KPIs:

- Waiting Time (WT), measured in minutes
- Predicted Waiting Time (PWT), calculated in minutes
- Queue Length (QL), measured by number of passengers in the queue
- Outflow, measured by number of passengers leaving the queue per hour
- Open Lines, measured by number of open security lines within a security control

Phases

The research was carried out in two distinct phases: an active period and a silent period. All the use cases involved diverting passengers from one security checkpoint to another, using the triggers for announcements explained earlier.

- Active period: During this 10-day phase, re-routing passengers was facilitated through automatic announcements made by the AAS, placed between the check-in area and the boarding pass control. These announcements were triggered when the Predicted Waiting Time (PWT) reached certain predefined thresholds.
- Silent period: To generate comparative data, a second 7-day study period was conducted. Throughout this phase, all announcements related to the use cases were suppressed, allowing for a clear comparison of the impact of the use cases on passenger flow.

Data and methods

The study split analysis into two key segments: long-term and short-term analysis, each using a quantitative approach. This dual approach enabled a comprehensive understanding of both the immediate and lasting effects of the announcements by AAS based on PFMS data.

- Long-term analysis: For the long-term analysis, the study focused on the overall impact of the use cases on passenger flow throughout the test period, on each day from 4:00 AM to 11:00 PM local time. This part of the study involved assessing the 25th, 50th, and 75th percentiles of all measured KPIs during both the silent phase of the test. The 25th percentile, for example, contains 25% of the measured data.
- Short-term analysis: Short-term analysis concentrated on the data collected 40 minutes before and after each automatically triggered announcement. This analysis was more focused and provided a snapshot of the immediate effects of the announcements on passenger flow.

To ensure the plausibility of their analysis, the researchers meticulously validated their data for both the long-term and short-term analyses. In the long-term analysis, they used split CSV files to calculate and cross-check the median values of all KPIs per hour, comparing these against manually calculated values in Excel files for both active and silent periods. For the short-term analysis, they cross-referenced the data frames in Python with the original CSV files, ensuring consistency in values. They also used Python script to verify the accuracy of plots for specific timestamps, comparing these with manually created plots from the same timestamps. This thorough cross-checking process was crucial to affirm the accuracy and reliability of their findings.

Findings

The number of open security lines didn't change much between the silent (without announcements) and active (with announcements) periods, but waiting time did. That is, the median value for open lines remained consistent across both periods, while the outflow saw a decrease. The outflow reflects the number of people processed through the checkpoint, which in these use cases was slightly lower than average, ranging from 2.58% to 9.82% across different security controls. This pattern indicates that the active interventions (announcements) played a significant role in managing passenger flow more efficiently and that improvements were not due to an increase in the number of open security lines nor speed of processing individuals (outflow did not increase).

Long-term analysis

Long-term analysis focused on the broader changes in KPIs, like waiting times and queue lengths from the silent period to the active period. In this analysis, significant changes in waiting times (WT) and queue lengths (QL) were observed, indicating the impact of various use cases.

Particularly at Terminal 1, Security Checkpoint 5 (T1 SC5), there was a notable decrease in both WT and QL during active periods. The median WT dropped by 9.57%, and the median QL reduced by 16.92%. Interestingly, at Terminal 1, Security Checkpoint 1 (T1 SC1), while the predicted waiting time (PWT) and QL saw substantial decreases (8.15% and 21.82% respectively), the actual WT only marginally reduced by 1%. This suggests a complex interplay of factors influencing passenger wait times. The table below reflects these findings.

		KPI				
	Percentile	Open Lines [Δ%]	Outflow [Δ%]	Predicted Waiting Time [Δ%]	Waiting Time [Δ%]	Queue Length [Δ%]
T1 SC1	0.25	0.00	-12.11	-29.14	-29.79	-43.48
	Median	0.00	-9.82	-8.15	-1.08	-21.82
	0.75	0.00	-14.90	-0.70	-6.49	-7.69
T1 SC5	0.25	0.00	-5.01	-23.93	-35.35	-19.75
	Median	0.00	-2.60	-11.29	-9.57	-16.92
	0.75	0.00	-2.23	-8.63	0.00	-7.96
T2 SC1	0.25	0.00	0.00	0.00	0.00	0.00
	Median	0.00	-2.58	0.00	0.00	0.00
	0.75	0.00	-5.08	-14.04	-16.13	-12.75

Table: Comparison of the percentage change between WT and QL between the silent and active period.

The consistent settings during the study periods imply that these improvements in WT and QL are directly attributable to the implemented strategies.

Short-term analysis

In the short-term analysis, the focus was on evaluating the immediate impact of announcements on passenger flow within a 40-minute timeframe following a triggered announcement.

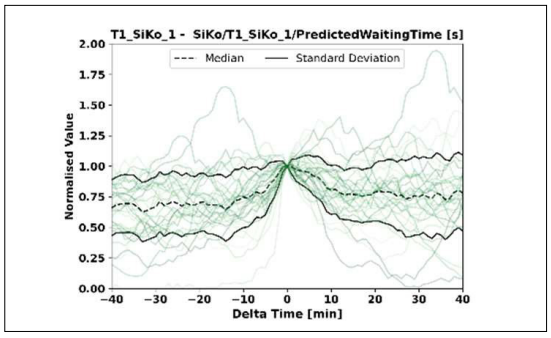
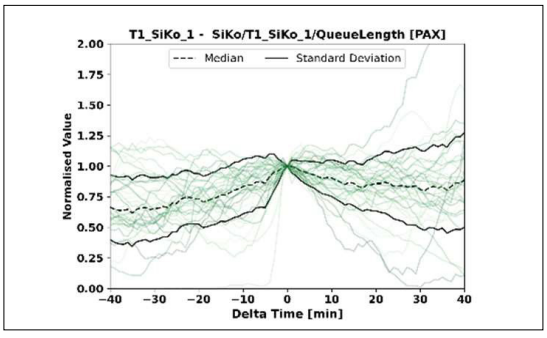
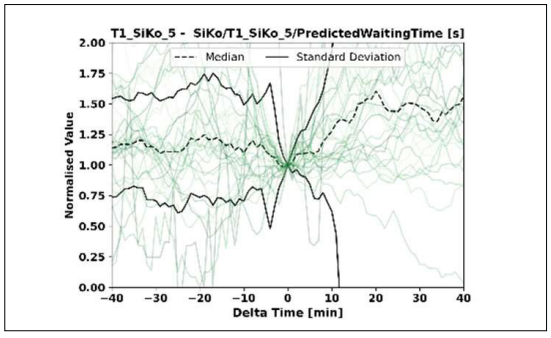
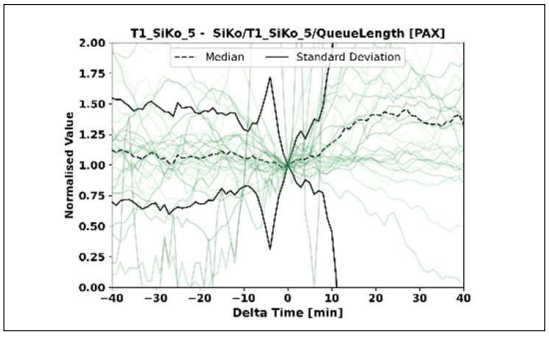
The primary objective was to verify the assumption that when passengers are redirected from one security checkpoint to another, there would be a decrease in Queue Length and Predicted Wait Time (PWT) at the former checkpoint, leading to a corresponding increase at the latter security checkpoint. This validation was essential to confirm the direct influence of announcements on passenger behavior.

The analysis unveiled a notable influence on Predicted Waiting Time (PWT) and Queue Length (QL) across all three use cases. The provided graphs display all measured data points, offering a representative overview of the progression of the corresponding curves.

The y-axis represents the normalized predicted waiting time/queue length, while the point of announcement is marked as zero (0) on the x-axis.

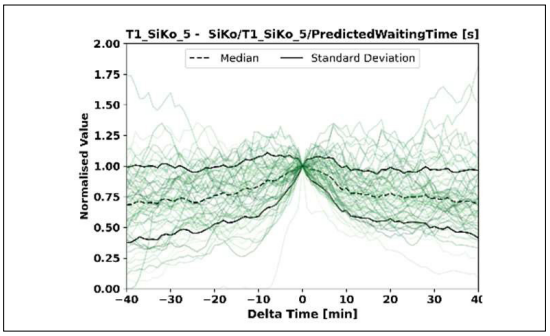
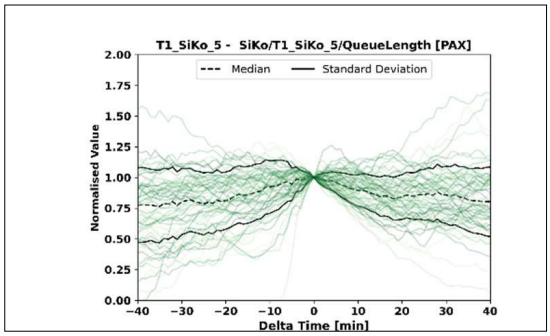
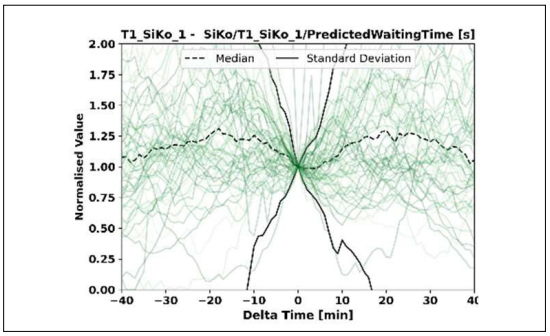
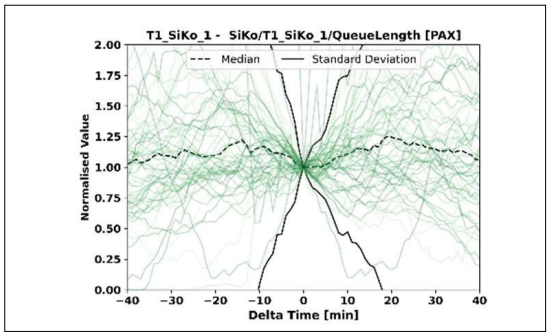
Use Case 1: Redirection from Terminal 1 Security Checkpoint 1 (T1 SC1) to Terminal 1 Security Checkpoint 5 (T1 SC5)

The findings indicate that following the announcement, the Predicted Waiting Time and Queue Length at Terminal 1 SC1 both decreased. This reflects the passengers‘ response to the announcement. Consequently, an increase was observed in both predicted waiting time and queue length at Terminal 1 Security Checkpoint 5 as passengers followed the redirection.

	Predicted Waiting Time	Queue Length
T1 SC1		
T1 SC5		

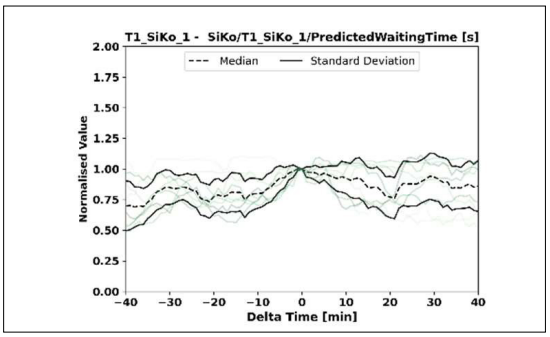
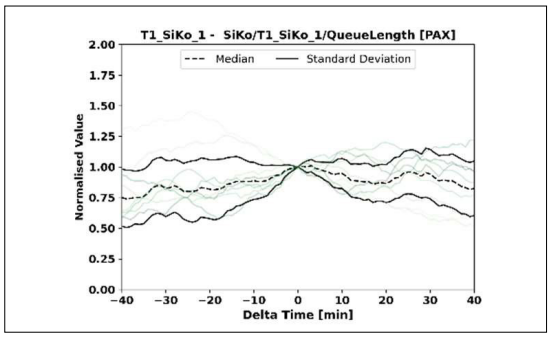
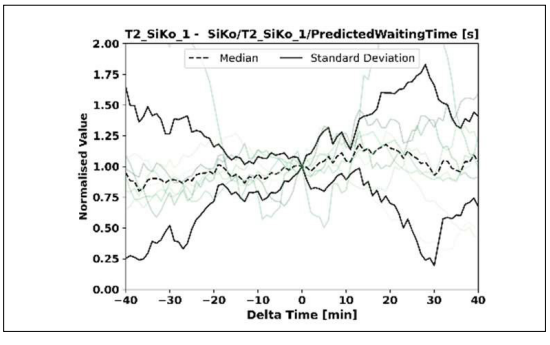
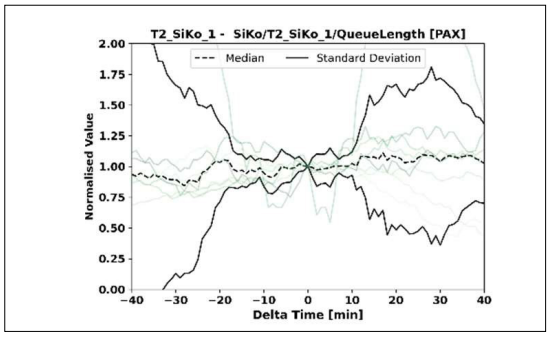
Use Case 2: Redirection from Terminal 1 Security Checkpoint 5 (T1 SC5) to Terminal 1 Security Checkpoint 1 (T1 SC1)

The same effect as observed in Use Case 1 is evident in the following analysis for Use Case 2.

	Predicted Waiting Time	Queue Length
T1 SC5		
T1 SC1		

Same for Use Case 3

The same effect as observed in Use Case 1 is evident in the following analysis for Use Case 3.

	Predicted Waiting Time	Queue Length
T1 SC1		
T2 SC1		

What are the broader implications of AAS-PFMS synergy?

Airports are investing heavily in passenger processing with the twin aims of managing throughput while ensuring that passengers have a great experience. Airports all over the world are rolling out technologies that speed up processing, reduce queues and keep passengers better informed, while also driving commercial revenue growth. Some 91% of airports report investment in these technologies.[5]

Enhancing passenger experience

Targeted and reduced announcements increase passenger understanding, trust, and well-being: Synergizing PFMS and AAS allows for highly targeted and specific announcements. By using predictive data from PFMS, airports can make announcements only when and where they are necessary, significantly reducing the overall number of announcements, so that each is timely and clear. This magnifies the importance and accuracy of each announcement, in turn ensuring that passengers are more likely to pay attention to them. Trust is heightened as passengers understand that they are made based on accurate and timely data.

The trend of "silent airports" is rapidly gaining popularity across continents with major airports adopting silent policies.[6] The aim is to enhance the passenger experience by significantly reducing noise pollution within terminals by minimizing the use of public address systems for routine announcements. The trend reflects a growing awareness in the aviation industry of the importance of passenger comfort and the impact of environmental factors like noise on the overall travel experience. However, this requires passengers to be more vigilant about their flight times and boarding procedures, as they can no longer rely on frequent audio reminders. The strategic use of technology like PFMS and AAS announcement systems in silent airports offers a balanced approach: It maintains operational efficiency and passenger convenience through essential, targeted communications, while significantly reducing the overall noise level.

Intelligent volume adjustment

The adjustment of announcement volumes can be intelligently managed based on PFMS data, with the AAS smartly responding to the number of people in an area: The volume of announcements is automatically increased for clarity and reach in crowded areas, and decreased where there are fewer people. An example is Zurich Airport, where the AAS controls the background music and over 2,500 manual and central announcements in the public area.

Data-driven business intelligence for efficient, cost-effective operations

People flow management systems enable airports to accurately measure and effectively manage passenger flow across the most complex environments. When implemented in airports in combination with AAS, these systems offer a solution to several critical operational challenges.

Efficiency

The integration of AAS and PFMS brings a new level of efficiency to airport operations, particularly in passenger processing. By leveraging real-time data from PFMS, AAS can make targeted announcements to redistribute passenger flow, easing congestion at checkpoints like security and boarding. This streamlined approach reduces delays and enhances the overall speed of operations. In turn, efficient passenger handling contributes to smoother flight schedules and positively impacts related areas like baggage handling.

Cost optimization

Cost reduction comes with better management of passenger flow, minimizing the need for extra staffing during peak hours and reducing time-related expenses associated with delays. It may help quicker aircraft turnaround by minimizing the time aircraft spend on the ground.

Agility and scalability

Agility and scalability in resource management are also enhanced by this technological synergy. The real-time insights provided by the PFMS enable airports to adapt swiftly to changing passenger volumes and behaviors. This flexibility is vital for handling peak travel times, unexpected surges in passenger numbers, and disruptions. The ability to quickly redirect passenger flows, balance the load across various checkpoints, and efficiently utilize staff and infrastructure underscores the growing trend towards creating more agile and responsive airport environments.

Ease of integration

The Integration of Sittig AAS and the Xovis PMFS is made simple through a standardized interface between the systems. Airports with both systems in place, or when they are newly installed, can easily link them, with minimal disruption to services.

Passenger redirection beyond security checkpoints

Passenger redirection extends beyond security checkpoints. It can be effectively implemented at various points within an airport, such as Entry/Exit Gates or Immigration Checkpoints and Check-In Areas, wherever PFMS data is gathered. This data-driven approach allows for the optimization of passenger flow throughout these critical areas.

Dynamic announcements

The AAS can automatically generate announcements that include dynamic content. For example, they can incorporate real-time information such as the expected wait time for passengers. This feature not only keeps passengers informed but also enhances their experience by managing their expectations and reducing uncertainty.

Navigating role-specific challenges

The research study that synergized PFMS and AAS at BER offers a lens through which we can view the specific needs of various roles related to enhancing operational efficiency and passenger experience within airports. These benefits arise from connecting passenger flow data to automatic announcements, allowing personnel to make automated decisions based on real-time data.

Terminal Operations Heads and COOs: The role of the Head of Terminal Operations or Chief Operating Officer is pivotal in ensuring efficient, uninterrupted airport operations. A primary challenge is managing the dynamic ebb and flow of passenger traffic, especially during peak hours and irregular operational scenarios like flight delays or cancellations. The data-driven approach of PFMS, when combined with the targeted communication of AAS, empowers these professionals with real-time insights. This enables them to rapidly respond to congestion, dynamically allocate resources, and automate tasks that would otherwise have to be done manually. This keeps operations fluid and reduces passenger wait times.

CIOs and Business Intelligence Heads: Chief Information Officers and Heads of Business Intelligence at airports constantly seek to leverage data to enhance operational decision-making. Their challenge lies in harvesting vast amounts of data for actionable insights. PFMS-AAS synergy offers a solution by providing precise, real-time data on passenger flow, enabling these leaders to fine-tune resource allocation, anticipate operational needs, and implement strategies that preempt bottlenecks. This setup helps in maximizing the utility of existing resources and infrastructure.

Technical Leads: Airport Technical Leads face the challenge of integrating complex systems while ensuring they are reliable, scalable, and user-friendly. The ability to seamlessly integrate PFMS and AAS sets a precedent in combining advanced tracking to create intelligent announcement systems. The technology can be adapted to different airport zones and varying passenger volumes, directly addressing the need to create a cohesive, efficient technological ecosystem within the airport.

Passenger Experience Managers: Passenger Experience Managers need to ensure a seamless, stress-free journey for travelers, from entry to boarding. PFMS and AAS integration helps by ensuring passengers receive timely, relevant information, significantly reducing anxiety associated with long waits and uncertainty. This targeted communication strategy ensures passengers are well-informed and can navigate the airport more confidently.

Conclusion – it's all about data-based, targeted announcements

The integration of PFMS and AAS at BER serves as a compelling case study in the effective use of data-driven business intelligence for enhancing airport operations. This approach is not a singular example but part of a larger trend in the aviation industry, where data analytics is increasingly recognized for its potential to transform key operational areas.

Airports are treasure troves of data, and with tools like PFMS and AAS, this data can be turned into automated actions and insights that lead to significant efficiency gains. Systems that capture detailed information about passenger movements and integrate this data with other airport databases are crucial for ensuring proper utilization of facilities and compliance with service level agreements.

Passenger Flow Management Systems that collect, transmit, and analyze data on various KPIs, offer insights for reducing response times to irregular queuing, improving customer satisfaction with predictive waiting times, and forecasting passenger flows for better operational resilience. These systems enable analysis based on historical data, which, coupled with real-time reporting, allows for precision planning, without significant capital spending.

Announcements are becoming increasingly vital in airport-passenger communication; however, it is only data-driven and targeted announcements that truly affect customer satisfaction and operational efficiency. Lessons from BER's implementation of PFMS and AAS extend far beyond a single airport's boundaries. They underscore the value of data-driven decision-making in the aviation industry – a trend that is reshaping how airports operate, making them more efficient, cost-effective, and responsive to the dynamic needs of air travel. This shift towards data-centric operations is not only about optimizing existing processes, it's about envisioning a more agile and intelligent future for airport operations.

About Xovis

Xovis is a market-leading technology company that develops, produces and distributes 3D sensors and related software solutions for precise counting and analysis of people flow worldwide. More than 110 airports already use Xovis' Passenger Flow Management System (PFMS) to increase throughput, reduce wait times and maximize operational efficiency at terminals of all sizes.

Xovis technology is characterized by simple integration, data protection compliance, high precision, and AI-based features. AERO, a fully managed passenger flow service, reflects the company's one-stop-shop approach to helping airport operators address a wide range of challenges.

Founded in 2008, Xovis has more than 200,000 sensors installed globally, employs around 130 people worldwide, and has offices in Boston, USA, and Bern, Switzerland.

About Sittig Technologies

Sittig is a renowned market leader in automatic announcement systems, with extensive usage not only in all major German airports but also in numerous international airports worldwide.

The software-based PAXGuide system automates high-quality general and boarding announcements in over 40 languages. This significantly improves process efficiency and customer experience. The system connects to existing hardware and integrates various systems to execute intelligent and targeted announcements.
With its PAXGuide platform, Sittig is a pioneer in data-driven automatic announcements.

Founded in 1987, Sittig serves customers in Europe, the Middle East, USA and Australia and has offices in Frankfurt, Munich, Vrable (Slovakia) and Chicago.

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