Secure Open Collaboration Framework powered by Artificial Intelligence

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Abstract

The D2.1 Platform Requirements document for the SOCFAI project outlines the technical and functional specifications for leveraging big data and AI to optimize airport and port operations, emphasizing scalable, secure, and integrated solutions to improve efficiency and the user experience.

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1 . Introduction

Welcome to the D2.1 Platform Requirements document of the SOCFAI project, an ambitious initiative that stands at the convergence of cutting-edge artificial intelligence and the pressing need for secure, efficient operational frameworks in the aviation and logistics sectors. This document delineates the technical and functional specifications required to build the SOCFAI platform—a cornerstone of our endeavor to harness AI for enhancing operational efficiency, security, and inter-stakeholder collaboration.

In an era where operational complexity is escalating and the demand for real-time, integrated management solutions has become critical, SOCFAI emerges as a beacon of innovation. It is designed to address and mitigate the challenges of operational inefficiencies, resource optimization, and fragmented situational awareness through a sophisticated AI-powered framework. Drawing from the insights and foundational work detailed in the Full Project Proposal (FPP), this document outlines the platform requirements essential for developing a system that not only meets the current needs but is also scalable and adaptable to the evolving dynamics of airport and logistics operations.

As we embark on this detailed exploration of the SOCFAI platform's requirements, we are guided by a vision that prioritizes security, openness, and collaboration. The requirements encapsulated in this document are meticulously crafted to ensure that the SOCFAI platform is robust, flexible, and capable of delivering tangible benefits to all stakeholders involved. By setting these stringent criteria, we aim to lay a solid foundation for a solution that revolutionizes operational management and sets new standards for excellence in the aviation and logistics industries.

Through this document, we invite our partners, stakeholders, and the broader community to engage with us in this journey. Together, we are not just building a platform; we are shaping the future of operational efficiency and collaboration, powered by the transformative potential of artificial intelligence.

1.1 Summary

The D2.1 Platform Requirements document for the SOCFAI project outlines a comprehensive framework for integrating and managing big data, specifically tailored to enhance airport and port operations through AI technologies. It details the technical specifications needed for scalable, efficient big data platforms capable of handling diverse, voluminous datasets to drive decision-making and operational efficiency. The document covers challenges and features of big data platforms, including scalability, performance, data storage, and management, emphasizing the importance of security, compliance, and user interface design. It also explores the integration requirements for various airport systems, predicting operational needs and visualizing scenarios to optimize efficiency and passenger experience. Moreover, it specifies port requirements and scenario-specific platform needs, ensuring the SOCFAI framework can adapt to different operational contexts and enhance collaborative efforts across sectors.

1.2 Big Data Platform Requirements, Challenges and Features

1.2.1 Consolidated Big Data Platform Requirements:

Following table presents a comprehensive overview of the essential requirements for a big data platform, outlining the key components and capabilities necessary for effective data handling, analysis, and management. Each requirement is defined to ensure that the platform can accommodate the needs of businesses and organizations in the era of big data. The requirements span from scalability, which ensures the platform's capacity to manage growing volumes of data efficiently, to data storage and management, focusing on the organization and robustness of data storage solutions. Performance highlights the platform's ability to process data swiftly for timely insights, while data integration and process emphasize the smooth incorporation and meaningful processing of data from various sources.

Analytics and reporting are essential for extracting and communicating insights from data, and security and compliance address the critical aspects of data protection and adherence to regulations. The reliability and fault tolerance of the platform guarantee continuous operation and data availability, with real-time processing enabling immediate data analysis and decision-making. The design of user interfaces and accessibility is considered for ease of use, alongside cost-effectiveness to ensure the platform's operation within budgetary constraints. Support for multiple languages and frameworks, cloud compatibility, and the availability of skilled talent are crucial for the platform's flexibility, scalability, and effective management.

Integration with existing systems ensures that the big data platform works seamlessly within an organization's current IT ecosystem, and data governance and management underline the importance of establishing clear policies and practices for data quality, security, and compliance. Together, these requirements form the foundation of a robust and efficient big data platform capable of meeting the diverse and evolving needs of modern data-driven organizations.

Requirement Name	Description
Scalability	The ability of the big data platform to handle increasing data volumes efficiently. Scalability ensures that the platform can grow to accommodate larger datasets without sacrificing performance.
Performance	The capability of the platform to quickly process and analyze large volumes of data. High performance is crucial for timely insights and efficient data processing.
Data Storage and Management	Involves implementing robust solutions for storing and managing diverse types of data. This includes selecting appropriate storage systems and structures for efficient data organization.
Data Integration and Process	The efficient handling of data from multiple sources, integrating it seamlessly into the platform, and processing it for meaningful insights. This involves ETL (Extract, Transform, Load) processes and data normalization.
Analytics and Reporting	Encompasses the availability of advanced analytics tools for extracting valuable insights from data. User-friendly reporting tools facilitate effective communication of these insights.
Security and Compliance	Involves implementing robust security measures to protect sensitive data and ensuring adherence to regulatory compliance, privacy policies, and industry standards.
Reliability and Fault Tolerance	The platform's ability to minimize downtime and maintain reliability, backed by mechanisms such as backup and recovery systems. This ensures data availability even in the face of failures.

Real-time Processing	The capability to process and analyze data in real-time, enabling immediate insights and actions based on the most up-to-date information.
User Interface and Accessibility	Encompasses the design of intuitive interfaces to facilitate ease of use for various types of users interacting with the big data platform.
Cost-effectiveness	Balancing the cost of resources with the functionality and performance of the platform. Efficient resource management is essential to control expenses.
Support for Multiple Languages and Frameworks	Compatibility with popular programming languages and data processing frameworks, allowing flexibility and integration with diverse tools.
Cloud Compatibility	The ability of the platform to seamlessly integrate with and leverage cloud services, providing flexibility and scalability.
Talent and Skill Availability	Involves acquiring and maintaining skilled professionals who possess the expertise required for effective data management and analysis within the big data platform.
Integration with Existing Systems	The seamless integration of the big data platform with the organization's current IT infrastructure, ensuring interoperability and smooth data flow.
Data Governance and Management	Encompasses establishing clear data policies and procedures, including metadata management, data lineage, and governance practices to ensure data quality, security, and compliance.

1.2.2 Big Data Platform Challenges

Following table delineates a series of challenges that organizations face in the realm of big data management and analysis. These challenges span various aspects of data handling, from the initial stages of data collection to the final stages of analysis and insight generation. Each challenge is described in terms of the specific difficulties it presents in the context of managing and leveraging large datasets effectively.

The challenges include handling the sheer volume of data, which requires efficient processing methods to avoid bottlenecks and ensure optimal performance. Managing the variety of data, from structured to unstructured forms, necessitates sophisticated integration techniques. The velocity of data, or the speed at which it is generated and needs to be processed, especially for real-time analytics, poses another significant challenge. Ensuring data quality and accuracy is crucial for maintaining the reliability of insights derived from big data. Data security and privacy are paramount, given the sensitive nature of information and the need to comply with regulations and best practices. Scalability and flexibility are essential for systems to adapt to data growth without performance loss, while cost management remains a constant challenge in balancing financial constraints with platform capabilities.

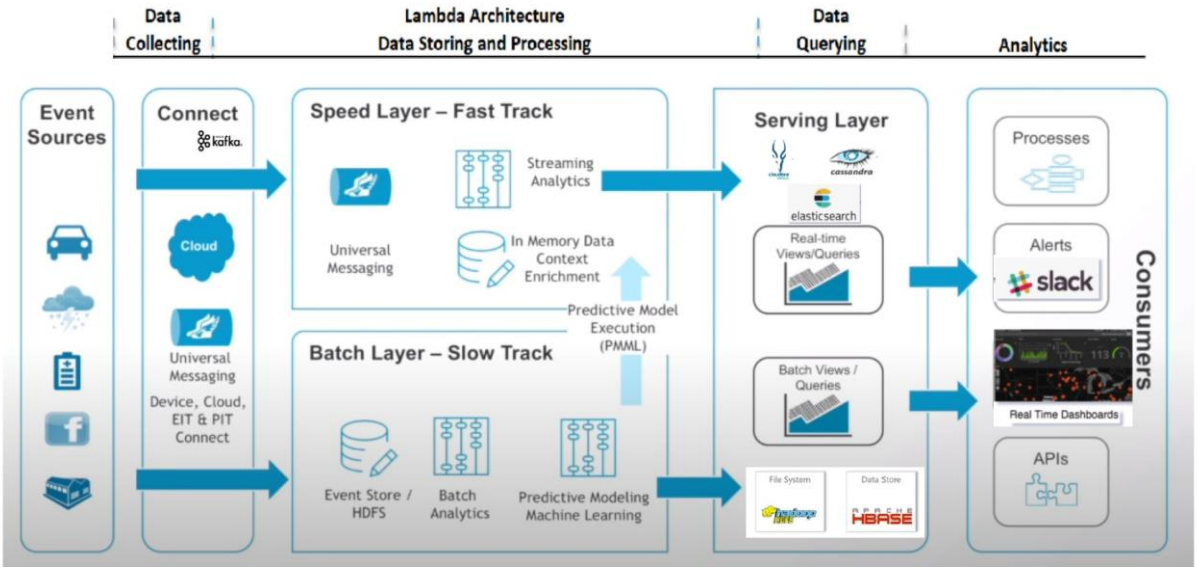
Integration with existing systems is necessary to ensure that the big data platform works seamlessly within an organization's current IT infrastructure. The availability of talent and skills specific to big data technologies is a critical need for effective data analysis. Data governance and management involve establishing clear policies and procedures to ensure data is managed correctly and meets quality

standards. The complexity of analysis refers to the difficulties in analyzing vast and intricate datasets, requiring advanced analytical techniques. Providing real-time analysis and actionable insights is crucial for timely decision-making in a fast-paced environment. Lastly, ethical and legal considerations must be navigated carefully to ensure that data collection and use adhere to moral standards and regulatory requirements.

Together, these challenges underscore the complexities of big data management and the multifaceted approach required to overcome them, ensuring that organizations can harness the full potential of their data assets.

Challenge Name	Description
Handling Data Volume	The challenge associated with managing and processing large volumes of data efficiently, avoiding bottlenecks and ensuring optimal performance.
Managing Data Variety	The challenge of integrating diverse data types effectively, considering structured, semi-structured, and unstructured data.
Coping with Data Velocity	The challenge of processing data quickly, particularly in scenarios that require real-time analytics and immediate data insights.
Ensuring Data Quality and Accur	The challenge of maintaining high data quality standards to ensure the reliability and accuracy of the information processed within the platform.
Data Security and Privacy	The challenge of protecting sensitive information and ensuring compliance with privacy regulations and security best practices.
Scalability and Flexibility	The challenge of adapting to data growth without compromising performance and maintaining flexibility to accommodate evolving data requirements.
Cost Management	The challenge of balancing expenses with the capabilities and functionalities offered by the big data platform.
Integration with Existing Systems	The challenge of seamlessly integrating the big data platform with current IT infrastructure, addressing compatibility issues and ensuring smooth data flow.
Talent and Skill Availab	The challenge of acquiring and retaining skilled professionals with the necessary expertise in big data technologies and data analysis.
Data Governance and Management	The challenge of establishing clear data policies and procedures, including metadata management and governance practices, to ensure effective data management.
Complexity of Analysis	The challenge associated with effectively analyzing vast datasets, considering the intricacies of data structures and relationships.
Providing Real-Time Analysis and Actionable Insights	The challenge of delivering timely insights for decision-making by enabling real-time data processing and analysis.
Ethical and Legal Considerations	The challenge of navigating ethical issues and ensuring compliance with legal requirements and regulations in the collection and use of data.

1.2.3 Data Architecture



2 . Airport Integration Requirements

2.1 Integration with Airport Operational Database and KPI's

An Airport Operational Database (AODB) system is a critical piece of technology infrastructure designed to centralize and manage the vast array of data essential for airport operations. It serves as the backbone for information flow within an airport, integrating data from various sources to provide a comprehensive operational view. The AODB system collects, stores, and disseminates real-time and historical data related to flights, passengers, baggage, crew, and airport resources.

The primary purpose of an AODB system is to optimize airport operations by ensuring that accurate and timely information is available to all stakeholders, including airport management, airlines, ground handling services, control towers, and other related parties. This information includes but is not limited to flight schedules, gate assignments, baggage claim information, and aircraft parking details.

AODB systems are used for a wide range of operations, such as:

- Flight Management: Managing flight schedules, including arrivals, departures, and the allocation of gates and stands. It ensures efficient utilization of airport resources and facilitates the smooth handling of flight operations.
- Resource Management: Allocating and managing airport resources such as check-in counters, baggage belts, and gates. It helps in optimizing the use of resources, reducing waiting times, and improving the overall efficiency of airport operations.

- Operational Planning and Control: Supporting the planning and control of day-to-day airport operations. This includes managing airport capacity, forecasting operational needs, and responding to real-time operational challenges.
- Information Sharing and Dissemination: Acting as a central hub for information sharing among all airport stakeholders. It ensures that all parties have access to consistent and up-to-date information, enabling coordinated actions and decision-making.
- Statistical Analysis and Reporting: Providing tools for the analysis of operational data and the generation of reports. This assists in strategic planning, performance monitoring, and the identification of areas for improvement.

By centralizing operational data, AODB systems play a crucial role in enhancing the efficiency, safety, and reliability of airport operations. They enable airports to manage their operations more effectively, improve passenger experience, and ensure timely and accurate communication between all parties involved in the airport ecosystem.

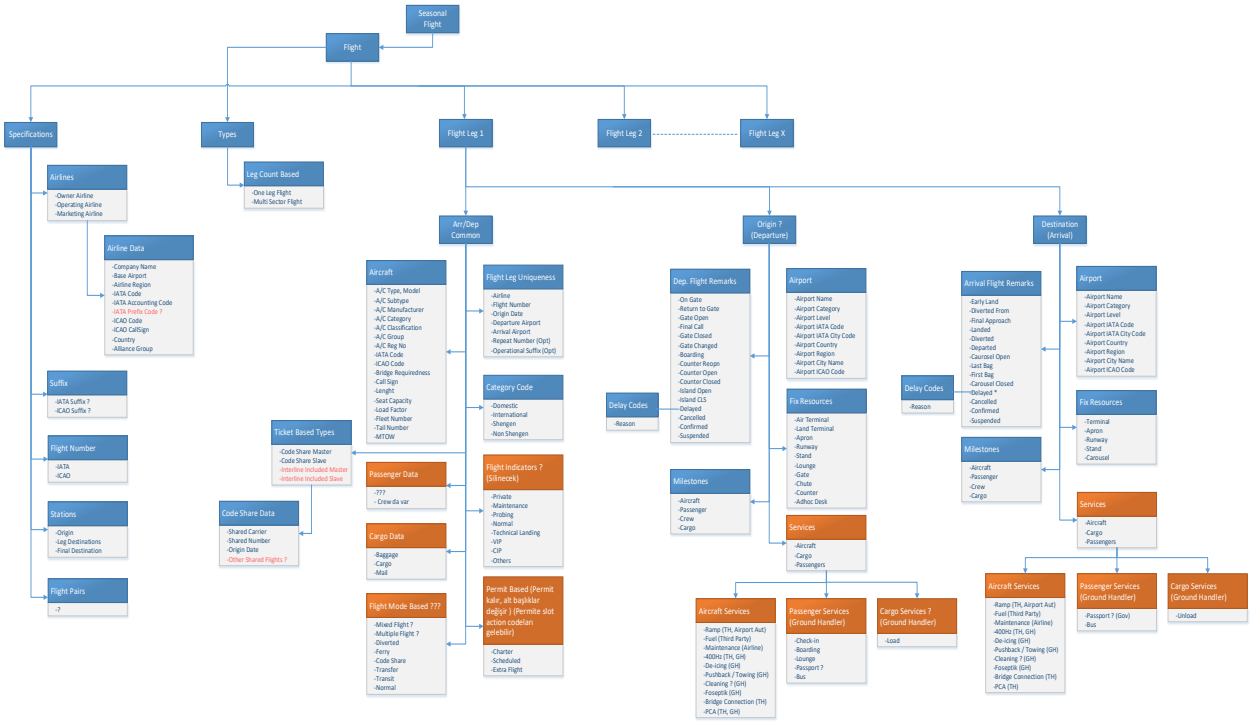


Figure 1 – Flight Data Structure

The structure related to flight data to be obtained from the AODB system has been shared in the graph above. The data obtained by utilizing the existing API structures of the AODB system will be analyzed and visualized on the platform side based on the KPIs defined below.

Following table outlines a comprehensive framework of Key Performance Indicators (KPIs) essential for managing and optimizing airport operations through the integration of Airport Operational Database (AODB) systems. These indicators are meticulously designed to monitor various aspects of airport functionality, including stand status, gate utilization, counter operations, passenger flow, and overall

airport efficiency. By leveraging the capabilities of AODB APIs, airports can access real-time and historical data to generate these KPIs, facilitating informed decision-making and operational improvements.

The indicators are categorized into single KPIs, which focus on specific operational points like single stands or gates, and overall KPIs, which provide a broader view of airport operations, such as overall stand capacities or passenger satisfaction levels. Some KPIs are intended for display on main maps for a macroscopic view, while others are detailed for sub-maps or direct map overlays, offering granular insights into specific areas or functions. Additionally, map alerts and detailed analyses are included for real-time operational adjustments and comprehensive understanding.

Generating KPIs with AODB APIs:

- Single Stand and Gate Status: By accessing real-time data on aircraft parking positions and gate assignments through AODB APIs, airports can dynamically update the occupancy status of stands and gates, facilitating efficient allocation and turnaround.
- Overall Capacities and Utilizations: AODB systems can aggregate data on the usage and availability of various airport resources, allowing for the calculation of utilization rates and the identification of potential bottlenecks or underused assets.
- Utilization Distributions and Detailed Utilisations: By analyzing historical and real-time data, airports can identify patterns in resource usage, enabling strategic planning for peak times and optimizing resource allocation.
- Flight Schedules for Stands and Gates: AODB APIs provide schedules and real-time updates on flight arrivals and departures, aiding in the precise planning of stand and gate assignments to minimize waiting times and ensure smooth operations.
- Passenger Flow and Satisfaction: Through the integration of passenger processing times, transfer delays, and satisfaction surveys, airports can monitor and enhance the passenger experience, addressing any issues that may arise.
- Security and Compliance Alerts: Real-time alerts generated from the AODB regarding cancellations, diversions, or delays ensure that all stakeholders are promptly informed, allowing for immediate action to mitigate impacts.
- Operational Efficiency Metrics: Data on turnaround times, average delays, and schedule completions provide insights into operational efficiency, enabling continuous improvement efforts.
- Resource Management: Detailed data on counter, carousel, and bus operations from the AODB system help manage passenger processing and baggage handling more effectively, ensuring resources are utilized optimally.

Name of Indicator	Description of Indicator	Type of Indicator	In Chart	Main Map	Sub-Map	In Map Direct	In Map Detail	Map Alert
Single Stand Status	This KPI tracks the current status of a particular stand (parking spot for an aircraft). It indicates whether the stand is occupied, reserved, or available, providing real-time information for stand allocation.	Single KPI		+		+		
Overall Stand Capacities and Utilisations	This KPI provides an aggregate view of the total number of stands, how many are in use, and the rate of utilization over time. It's crucial for understanding how effectively the available stands are being used.	Overall KPI	+					
Stand Utilisation Distributions	This KPI analyzes the distribution of stand utilization, helping to identify patterns or trends, such as peak usage times or stands that are consistently over or underused.	Overall KPI	+					
Single Stand Utilisation	Similar to the single stand status, this KPI focuses on how much a particular stand is being used, providing a detailed view of its utilization over time.	Single KPI		+		+	+	
Single Stand Prev and Next Flights	This KPI provides information about flights that have recently used a stand and the next flights scheduled to use it, aiding in efficient stand allocation and scheduling.	Single KPI					+	
Overall Average Airline Stack Waiting Times per Flight	This KPI measures the average waiting time for flights from a particular airline before they can be allocated a stand, helping to identify bottlenecks or inefficiencies in stand allocation.	Overall KPI	+					
Overal Gate Capacities and Utilisations	Similar to stand capacities, this KPI provides data on the number of gates, their current occupancy, and overall usage rates, offering insights into gate management efficiency.	Overall KPI	+					
Gate Status	This KPI indicates the current status (occupied, reserved, available) of each gate, essential for real-time gate management and allocation.	Single KPI				+		
Single Gate Utilisation	This KPI focuses on the utilization of a specific gate, providing detailed data on its usage patterns over time.	Single KPI					+	
Next Flights for Gates	This KPI shows the upcoming flights scheduled for each gate, aiding in gate planning and ensuring smooth transitions between flights.	Single KPI					+	
Overall Counter Capacities and Utilisations	This KPI provides an overview of check-in and boarding counter capacities versus their current usage, highlighting the efficiency of passenger processing areas.	Overall KPI	+					
Counter Status	Indicates the current status (open, closed, reserved) of each counter, essential for operational planning and passenger flow management.	Single KPI				+		
Single Counter Utilisation	Tracks the usage of a specific counter, offering insights into individual counter performance and usage patterns.	Single KPI					+	

Next Flights for Counters	Shows the next flights to be processed at each counter, helping in resource allocation and ensuring counters are prepared for upcoming flights.	Single KPI					+	
Overall Carousel Capacities and Flight Utilisations	This KPI measures the total number of baggage carousels, their current usage, and how efficiently they are being used to handle the luggage of incoming flights.	Overall KPI	+					
Carousel Flight Distributions	Analyzes how flights are distributed across different baggage carousels, aiding in the balanced allocation of flights to carousels.	Overall KPI	+					
Next Flights for Carousels	Indicates the upcoming flights assigned to each carousel, ensuring preparedness and efficient baggage handling.	Single KPI					+	
Average Transfer Pax Delay	Measures the average delay experienced by transfer passengers, crucial for assessing and improving the transfer experience at the airport.	Overall KPI	+					
Total Arrival Passenger Delays and Avr. Delay per Passenger	This KPI tracks the total delay time experienced by arriving passengers and the average delay per passenger, providing insights into the efficiency of arrival processes.	Overall KPI	+					
Total Departure Passenger Delays and Avr. Delay per Passenger	Similar to arrival delays, this KPI measures the total and average delay per departing passenger, highlighting areas for improvement in departure processes.	Overall KPI	+					
Single Counter Passenger Arrivals	Tracks the number of passengers processed at a specific counter, offering a detailed view of counter performance and passenger flow.	Single KPI					+	
Overal Daily Passenger Satisfaction	Measures the overall satisfaction level of passengers on a given day, essential for assessing service quality and identifying areas for improvement.	Overall KPI	+					
Passenger Distribution per Airline	Analyzes how passengers are distributed among different airlines, useful for understanding airline performance and passenger preferences.	Overall KPI	+					
Passenger Distribution per Destination	Shows how passenger numbers vary according to destination, aiding in route and capacity planning.	Overall KPI	+					
Passenger Distribution per Arrival / Departure	Compares the number of arriving and departing passengers, offering insights into airport traffic flow and operational demands.	Overall KPI	+					
Passenger Distribution per Int/Dom	Differentiates passenger numbers between international and domestic flights, crucial for resource allocation and service planning.	Overall KPI	+					

Transit and Transfer Passengers Ratio	Measures the ratio of transit passengers (those staying in the airport) to transfer passengers (those switching flights), important for managing passenger flow and services.	Overall KPI	+					
Transported Passengers	Tracks the total number of passengers transported, a fundamental indicator of airport traffic and operational volume.	Overall KPI	+					
Arr Flight Distribution per Airline	Analyzes how arriving flights are distributed among different airlines, providing insights into airline operations and scheduling.	Overall KPI	+					
Arr Flight Distribution per Origin	Shows the distribution of arriving flights based on their origin, useful for understanding traffic patterns and route popularity.	Overall KPI	+					
Arr Flight Distribution per AC Categories	Breaks down arriving flights by type or category of aircraft, aiding in resource and infrastructure planning.	Overall KPI	+					
Arr Flight Distribution per Int/Dom	Differentiates arriving flights between international and domestic, important for operational and service planning.	Overall KPI	+					
Arr Flight Distribution per Flight Service Type	Categorizes arriving flights by service type (e.g., commercial, cargo), providing insights into different operational needs and priorities.	Overall KPI	+					
Arr On-Time Puncuality Level 1	Measures the punctuality of arriving flights within a specific timeframe, indicating the efficiency of airport and airline operations. Level 1 - the percentage of flights that operate within +/- 3 (On time Punctuality-OTP) minutes; Level 2 - the percentage of flights that operate within +/- 15 minutes of scheduled time	Overall KPI	+					
Arr On-Time Puncuality Level 2	Similar to Level 1 but might involve a different, usually stricter, timeframe for measuring punctuality. Level 1 - the percentage of flights that operate within +/- 3 (On time Punctuality-OTP) minutes; Level 2 - the percentage of flights that operate within +/- 15 minutes of scheduled time	Overall KPI	+					
Arrival Cancellations	Tracks the number of flights cancelled, offering insights into operational issues and aiding in contingency planning.	Overall KPI	+					
Arrival Cancellation Alerts	Provides real-time alerts about flight cancellations, crucial for operational response and passenger communication.	Alert						
Arr Night Jets Movements	Monitors the movements of jets during nighttime, important for noise management and compliance with curfews or operational restrictions.	Overall KPI	+					

Early Arrivals	Tracks flights that arrive earlier than scheduled, affecting stand, gate, and service planning.	Overall KPI	+					
Early Arrival Alert	Provides real-time alerts for early arrivals, allowing staff to adjust resources and services promptly.	Alert						+
Arrival Delays Distribution per Airline	Analyzes how arrival delays are distributed among different airlines, offering insights into specific operational issues or challenges.	Overall KPI	+					
Arrival Delays Distribution per Region	Shows how arrival delays vary by geographic region, aiding in understanding broader traffic and operational patterns.	Overall KPI	+					
Arrival Delays Distribution per AC Type	Breaks down arrival delays by aircraft type, useful for identifying specific issues related to certain types of aircraft.	Overall KPI	+					
Arrival Delays Distribution per X	This seems incomplete. "X" could stand for a specific variable (e.g., time of day, gate, cause of delay), providing a more focused insight into factors affecting arrival delays.	Overall KPI	+					
Average Arrival Load Factor of Airport	This KPI measures the average percentage of occupied seats for incoming flights. A higher load factor indicates a higher utilization of aircraft capacity on arrival.	Overall KPI	+					
Average Arrival Load Factor Distributions of Airlines	This KPI breaks down the average arrival load factor by individual airlines, showing how well each airline is filling its incoming flights.	Overall KPI	+					
Dep Flight Distribution per Airline	This KPI shows the distribution of departing flights among different airlines, providing insights into the operations and scheduling efficiency of each airline.	Overall KPI	+					
Dep Flight Distribution per Origin	This KPI tracks the number of departing flights from different origins, which can help in understanding route popularity and planning for demand.	Overall KPI	+					
Dep Flight Distribution per AC Type	This shows how departing flights are distributed based on the type of aircraft, aiding in managing resources specific to different aircraft types.	Overall KPI	+					
Dep Flight Distribution per Int/Dom	This measures the ratio of international to domestic departing flights, which is important for resource allocation and service planning.	Overall KPI	+					
Dep Flight Distribution per Flight Service Type	This KPI categorizes departing flights by service type (e.g., passenger, cargo), which can impact gate assignments and service requirements.	Overall KPI	+					
Departure Cancellations	This measures the number of flights that are cancelled, which can indicate larger operational issues or external factors affecting the airport.	Overall KPI	+					

Departure Cancellation Alerts	This involves real-time notifications about flight cancellations, allowing airport staff to manage the situation and communicate with passengers effectively.	Alert						+
Dep Night Jets Movements	Tracks the number of jet movements during night hours, which is important for noise management and curfew compliance.	Overall KPI	+					
Departure Delays Distribution per Airline	This KPI shows how departure delays are spread across different airlines, which can highlight specific airline-related issues.	Overall KPI	+					
Departure Delays Distribution per GH Company and Total Delays per GH Companies	This KPI assesses the performance of ground handling companies by analyzing departure delays attributed to them	Overall KPI	+					
Departure Delays Distribution per AC Type	This indicates how departure delays vary according to aircraft type, useful for identifying potential issues related to specific aircraft models.	Overall KPI	+					
Departure Delays Distribution per Flight Service Type	Breaks down departure delays by flight service type, helping to address different operational needs.	Overall KPI	+					
Departure Delays Distribution per X	This KPI seems to indicate a distribution of delays across an unspecified variable 'X', which could be a specific factor like gate, time of day, etc.	Overall KPI	+					
Average Take Off Delays	Measures the average delay experienced by flights at take-off, reflecting the efficiency of airport departure processes.	Overall KPI	+					
Departure Delay Codes Counts	This KPI counts the occurrences of different coded reasons for departure delays, which is crucial for identifying and addressing systemic issues.	Overall KPI	+					
Dep On-Time Punctuality (with Adj. Punct. and On-Time Punct.)	This KPI measures the punctuality of departures, with adjusted punctuality potentially accounting for mitigating factors and on-time punctuality representing strict adherence to schedule.	Overall KPI	+					
Average Departure Load Factor of Airport	Similar to arrival load factor, this KPI measures the average percentage of occupied seats on departing flights.	Overall KPI	+					

Average Departure Load Factor Distribution of Airlines	This KPI shows the departure load factor broken down by airlines, indicating how well each airline is filling its outgoing flights.	Overall KPI	+					
Daily Schedule Completion	This KPI tracks the percentage of the daily flight schedule that is completed, an indicator of overall operational efficiency.	Overall KPI	+					
Average Turnaround Time	Measures the average time taken between the arrival and subsequent departure of an aircraft, a critical factor in airport efficiency.	Overall KPI	+					
Real Aircraft Count vs Planned Aircraft Count per Hours	Compares the actual number of aircraft at the airport versus the planned number on an hourly basis, indicating the accuracy of scheduling and planning.	Overall KPI						
Turnaround Time Distributions per Airlines	Analyzes how turnaround time varies among different airlines, which can highlight efficiency or delays specific to airlines.	Overall KPI	+					
Turnaround Time Distributions per AC Categories	This KPI shows how turnaround time varies by aircraft category, useful for resource planning for different aircraft types.	Overall KPI	+					
Turnaround Time Distributions per GH Companies	Breaks down turnaround times by ground handling company, showing the efficiency of different ground services.	Overall KPI	+					
Turnaround Time Distributions per Terminals	Analyzes how turnaround times vary across different terminals, which can inform terminal operations and management.	Overall KPI	+					
Average Ground Delay	This KPI measures the average delay experienced by aircraft on the ground, including taxiing and queuing times.	Overall KPI	+					
Diverted Flight Counts	Counts the number of flights that had to be diverted from their scheduled arrival airport, which is important for understanding irregular operations.	Overall KPI	+					
Average Load Factor of Airport	This KPI measures the average percentage of seats filled on all flights (arriving and departing) at the airport. It provides an overall indication of how full flights are, which is a key metric for airlines and airport revenue management.	Overall KPI	+					

Overal Load Factor Distributions per Airlines	This KPI analyzes how the load factor varies among different airlines operating at the airport. It can show which airlines have higher occupancy rates and could influence decisions on flight frequencies and aircraft allocation.	Overall KPI	+					
Total Bus Distance	This KPI calculates the cumulative distance covered by airport buses over a certain period. It can help in assessing the efficiency of bus operations and determining the cost related to passenger transportation on the tarmac or between terminals.	Total KPI	+					
Average Bus Distance Distribution per Airline	This metric shows the average distance airport buses travel for each airline, potentially reflecting the gate allocations and efficiency of boarding and deplaning processes for different airlines.	Total KPI	+					
Average Bus Distance Distribution per GH Companies	This measures the average distance covered by buses operated by each ground handling company. It can indicate how effectively ground handling companies are managing their passenger transport responsibilities, which can impact overall airport efficiency and passenger satisfaction.	Total KPI	+					

2.2 Integration with PFM, Pax Analyzer and KPI's

TAV Technologies Passenger Flow Management Solution is a cutting-edge system designed to enhance airport operations by providing comprehensive insights into passenger movements throughout the airport. This innovative solution leverages advanced technologies, including data analytics, sensors, and real-time tracking, to monitor and analyze the flow of passengers from the moment they enter the airport until they board their flights. By doing so, it aims to optimize the passenger experience, improve operational efficiency, and increase overall airport capacity. The core of TAV Technologies' solution lies in its ability to collect and process vast amounts of data from various points within the airport ecosystem. This includes entry and exit points, check-in counters, security checkpoints, boarding gates, and retail areas. The system utilizes this data to identify bottlenecks, predict congestion points, and provide actionable insights to airport management, enabling them to make informed decisions to streamline passenger flow and reduce waiting times.

On the other hand, TAV Technologies Pax Analyzer Solution is a sophisticated analytics tool specifically designed to empower airports and airlines with deep insights into passenger behavior, preferences, and flow patterns. This state-of-the-art solution harnesses the power of big data analytics, machine learning, and sensor technologies to collect, process, and analyze vast amounts of passenger data in real time. By doing so, it enables airport operators and airlines to make informed decisions that enhance the passenger experience, optimize operational efficiency, and increase commercial opportunities. The Pax Analyzer stands out for its ability to seamlessly integrate with existing airport infrastructure, including ticketing systems, boarding gates, security checkpoints, and retail outlets, to gather comprehensive data on passenger movements and activities. This integration allows for a holistic view of the passenger

journey, from arrival at the airport to departure, including dwell times in various zones such as lounges, retail areas, and boarding gates.

Following table outlines a comprehensive framework of Key Performance Indicators (KPIs) crucial for managing and optimizing the flow and experience of passengers within an airport setting. Through the integration of TAV Technologies Pax Analyzer and Passenger Flow Management solutions, airports are equipped to monitor, analyze, and improve various facets of passenger processing and movement. These solutions leverage advanced analytics, real-time tracking, and predictive modeling to generate actionable insights, enabling airports to enhance efficiency, reduce waiting times, and improve passenger satisfaction. The indicators are categorized based on the operational aspect they measure, such as gate processing times, counter efficiency, lounge utilization, and overall passenger flow. Each KPI is designated for visualization in charts, main and sub-maps, direct map overlays, detailed map views, or as part of an alert system, depending on its nature and the level of detail required for effective monitoring and decision-making.

Generating KPIs with Pax Analyzer and Passenger Flow Management Solutions API's:

- Passenger Processing Times: By tracking real-time data on passenger movement and activities, these solutions can calculate average processing times at key points like gates, counters, and security checks. This data helps identify bottlenecks and streamline passenger flow.
- Utilization and Capacity Metrics: Through continuous monitoring of passenger numbers and facility usage, the solutions provide insights into the utilization rates of lounges, counters, carousels, and security checkpoints, aiding in resource allocation and infrastructure planning.
- Queue Management: By analyzing queue lengths and wait times in real time, the systems can trigger alerts for long queues, enabling immediate operational adjustments to manage congestion and improve passenger experience.
- Forecasting and Predictions: Utilizing historical data and predictive analytics, the solutions forecast passenger arrival rates, queue lengths, and processing times, allowing for proactive resource planning and scheduling to accommodate expected passenger flows.
- Passenger Flow and Distribution: By aggregating data from various collection points, these technologies map out passenger flow patterns throughout the airport, identifying high-traffic areas, peak times, and potential areas for commercial optimization.
- Emergency and Safety Management: In critical situations, the systems can calculate emergency exit times and trigger alerts for overcrowding or other safety concerns, enhancing the airport's ability to manage emergencies effectively.
- Operational Alerts: Real-time alerts for operational delays, such as lounge opening or closing delays, border control processing lags, or boarding and disembarkation inefficiencies, ensure that management can swiftly address issues as they arise.

By leveraging the APIs of TAV Technologies Pax Analyzer and Passenger Flow Management solutions, airports can harness a wealth of data to generate these KPIs, offering a granular and holistic view of operational performance and passenger experience. This integrated approach not only drives operational excellence but also fosters a more seamless, efficient, and enjoyable journey for passengers, positioning the airport as a leader in customer satisfaction and operational efficiency.

Name of Indicator	Description of Indicator	Type of Indicator	In Chart	Main Map	Sub-Map	In Map Direct	In Map Detail	Map Alert
Overall Average Gate Passenger Processing Time	This KPI measures the average time it takes for passengers to be processed at the gate, including any checks and boarding.	Overall KPI	+					
Gate Passenger Processing Time Distribution per Gates	This indicates the variation in processing times across different gates, which can highlight inefficiencies or best practices.	Overall KPI	+					
Gate Passenger Processing Time Distribution per Airlines	Shows the differences in processing times that passengers experience with different airlines at the gate.	Overall KPI	+					
Overall Average Counter Passenger Processing Time	This KPI calculates the average time it takes for passengers to be processed at check-in counters.	Overall KPI	+					
Counter Passenger Processing Time Distribution per Airlines	Measures the variance in processing times at check-in counters for different airlines.	Overall KPI	+					
Counter Passenger Processing Time Distribution per Counter Classes	Differentiates processing times based on counter classes (e.g., economy, business, first-class).	Overall KPI	+					
Overall Queue Losses	This KPI quantifies the impact of queue times on potential sales or service opportunities, considering how long waits might lead to passenger dissatisfaction or lost revenue.	Overall KPI	+					

Average passenger processing time of CO	The average time it takes for passengers to complete the check-out process, likely at the gate or after landing.	Single KPI					+	
Single Counter Total Processed Passenger	The total number of passengers processed by a single counter over a specified period.	Single KPI					+	
Queue Lenght of Counter	Measures the average number of passengers waiting in line at a counter at any given time.	Single KPI					+	
Long Queue Alert	A system alert that is triggered when the queue length exceeds a predetermined threshold, indicating potential processing delays.	Alert						+
Counter Queue Predictions (Passenger Arrival Predictions for Flights)	Forecasts the number of passengers arriving at counters for check-in, allowing for resource planning to meet demand.	Prediction						
Average passenger processing time of CR	This KPI measures the average time passengers spend waiting for their luggage at baggage carousels.	Single KPI					+	
Carousel Crowd Alert	An alert that notifies when there is overcrowding at a carousel, potentially requiring intervention to maintain service standards and safety.	Alert						+
Overall Lounge Capacities and Flight Utilisations	Measures how well airport lounges are being utilized in relation to flight schedules.	Overall KPI	+					
Overall Lounge Capacities and Passenger Utilisations	This KPI tracks the utilization of lounges by passengers, indicating if facilities are adequate or under/over-utilized.	Overall KPI	+					
Lounge Passenger Distributions per Lounges	Shows how passengers are distributed across different lounges, which can indicate preferences or overuse of certain facilities.	Overall KPI	+					
Lounge Passenger Distributions per Airlines	Measures the distribution of airline passengers using lounges, which could reflect service agreements or loyalty program benefits.	Overall KPI	+					

Lounge Status	Indicates the current operational status of lounges (open, closed, under maintenance).	Single KPI				+		
Single Lounge Flight Utilisation	Reflects how a particular lounge is being used in relation to specific flights, which could be indicative of peak usage times.	Single KPI					+	
Single Lounge Passenger Utilisation	Measures the usage of a single lounge by passengers over a given period.	Single KPI					+	
Lounge Crowd Alert	Notifies when the number of passengers in a lounge exceeds its comfortable capacity.	Alert						+
Lounge Opening Delays	Tracks delays in lounge openings, which could affect passenger satisfaction and lounge revenue.	Alert						+
Lounge Closing Delays	Monitors delays in lounge closings, ensuring that they are operating within their scheduled hours.	Alert						+
Overall BC Capacities and Utilisations	Assesses the capacity and utilization rates of border control facilities and services at the airport.	Overall KPI	+					
Overall Average BC Passenger Processing Time	The average time taken to process a border control passenger, potentially at check-in, security, or boarding.	Overall KPI	+					
BC Passenger Processing Time Distribution per BC Desk	Analyzes the variance in processing times across different border control desks or counters.	Overall KPI	+					
Overall Queue Losses	Similar to other queue loss KPIs, this measures the impact of queuing in the border control context.	Overall KPI	+					
Single BC Utilisation	Reflects the use of a single border control service or facility.	Single KPI					+	
Average passenger processing time of BC	The average time taken for processing border control passengers at various points in their journey.	Single KPI					+	
Queue Lenght of BC	The average number of border control passengers waiting in queues at any given point.	Single KPI					+	
BC Opening Delays	Monitors any delays in opening border control services or facilities.	Single KPI						+

BC Closing Delays	Tracks any delays in the closing of border control services or facilities.	Single KPI						+
Long Queue Alert	An alert that signals when queues at border control counters or facilities exceed a certain length.	Single KPI						+
Overall SC Capacities and Utilisations	This KPI measures the total capacity of Security Checks (SC) and how much of that capacity is being utilized. It helps in understanding if the available resources are adequate or under/over-utilized.	Overall KPI	+					
Overall Average SC Passenger Processing Time	This refers to the average time taken to process a passenger through security checks across the entire airport.	Overall KPI	+					
SC Passenger Processing Time Distribution	This KPI looks at how the processing times are distributed. For example, it could show whether most passengers are processed quickly or if there are delays that affect a significant number of passengers.	Overall KPI	+					
Overall Queue Losses	This metric accounts for passengers who leave a queue before being processed, which could indicate long wait times or inefficiencies in the queuing process.	Overall KPI	+					
Single SC Utilisation	This is the utilization rate of individual security checkpoints, as opposed to the overall utilization across all checkpoints.	Single KPI					+	
Average passenger processing time of SC	Similar to the overall average, but this may focus on a single SC or be a different way of calculating or presenting the average time metric.	Single KPI					+	
Queue Length of SC	This indicates the number of passengers waiting in line at a security checkpoint at any given time.	Single KPI					+	
Long Queue Alert	This would be a trigger or alert system that notifies airport staff when a queue exceeds a certain length or wait time, suggesting that action may be needed to address the situation.	Alert						+
Average Passenger Boarding Time	The average time it takes for passengers to board their aircraft. This can include the time from when boarding begins to when the last passenger boards.	Overall KPI	+					
Passenger Boarding Time Distribution per Airlines	This KPI breaks down the average boarding time by airline, which can highlight differences in boarding efficiency between carriers.	Overall KPI	+					

Passenger Boarding Time Distribution per AC Types	This KPI measures the boarding time distribution across different aircraft types, useful for determining how aircraft design affects boarding.	Overall KPI	+					
Passenger Boarding Time Distribution per GHS Company	This analyzes the boarding time distribution based on the Ground Handling Services company managing the boarding process.	Overall KPI	+					
Passenger Boarding Time Distribution per Int / Dom Status	This KPI differentiates boarding times based on whether flights are international (Int) or domestic (Dom).	Overall KPI	+					
Average Passenger Disembarkation Time	This is the average time it takes for passengers to disembark the aircraft upon landing.	Overall KPI	+					
Passenger Disembarkation Time Distribution per Airlines	This distribution shows how disembarkation times vary by airline.	Overall KPI	+					
Passenger Disembarkation Time Distribution per AC Types	This KPI measures how disembarkation times vary across different types of aircraft.	Overall KPI	+					
Passenger Disembarkation Time Distribution per GHS Company	This analyzes how the Ground Handling Services companies affect the disembarkation times of passengers.	Overall KPI	+					
Passenger Disembarkation Time Distribution per Int / Dom Status	This measures disembarkation times, distinguishing between international and domestic flights.	Overall KPI	+					
Average Security Control Passenger Processing Time	This is the average time it takes for a passenger to go through security control procedures.	Overall KPI	+					

Average Border Control Passenger Processing Time	This KPI measures the average time for passengers to pass through border control, which is important for international flights.	Overall KPI	+					
Zone Sizes per Passengers	This indicates the size of different zones within the airport relative to the number of passengers they serve.	Overall KPI	+					
Passenger Counts in Zones	This counts how many passengers are present in different zones of the airport at any given time.	Single KPI				+		
Passenger Counts in Markets	This KPI measures the number of passengers in commercial areas, like duty-free shops and restaurants.	Single KPI				+		
Passenger Flow Monitoring	This is the ongoing observation and analysis of how passengers move through the airport, which can be used to manage congestion and improve the passenger experience.	Overall KPI				+		
Emergency Exit Time Calculations for Zones	This KPI calculates the time it would take for passengers to evacuate the airport from different zones in case of an emergency.	Alert						+

2.3 Integration with Building Systems and KPI's

There are several Scada systems exist in TAV Adnan Menderes Airport to monitor and control building systems. Following KPI's will be generated with the data generated with those systems.

Name of Indicator	Description of Indicator	Type of Indicator	In Chart	Main Map	Sub-Map	In Map Direct	In Map Detail	Map Alert
Temperatures of Zones	This measures the temperature in different areas or zones of the airport. Monitoring this ensures passenger comfort and helps in energy management.	Single KPI				+		

Temperature Alerts of Zones	Alerts generated when the temperature in any zone deviates from a set range, possibly indicating a malfunction or need for adjustment in HVAC systems.	Single KPI						+
CO2 Level of Zones	The concentration of carbon dioxide in different airport zones. High levels can indicate poor air quality or ventilation issues.	Single KPI				+		
CO2 Level Alerts	Notifications triggered when CO2 levels exceed predefined thresholds, potentially impacting air quality.	Single KPI						+
Humidity of Zones	This refers to the moisture content in the air of various airport zones, which can affect passenger comfort and building infrastructure.	Single KPI				+		
Humidity Alerts of Zones	Alerts issued when humidity levels fall outside the desired range, which may require adjustments to air handling systems.	Single KPI						+
Bridge Connection Status	The operational status of jet bridges (the movable connectors that link the terminal to the aircraft), which is critical for boarding and deplaning.	Single KPI					+	
Single 400 Hz Connection Status	Monitors whether the 400 Hz power supply, used to power parked aircraft, is connected and functioning for individual gates.	Single KPI					+	
400 Hz Power Consumption Distribution per Airlines	The amount of 400 Hz power used by each airline, which could be used for billing or energy management.	Overall KPI	+					

Single PCA Connection Status	Checks if the Pre-Conditioned Air (PCA) systems, used to control aircraft climate while parked, are connected for each gate.	Single KPI					+	
PCA Consumption Distribution per Airlines	Tracks PCA usage by each airline, which may be relevant for operational costs and environmental control.	Overall KPI	+					
Electricity Consumption of Each Zones and Each Equipment	Detailed tracking of electricity use by different areas and equipment, essential for energy management.	Single KPI				+		
Overall Electricity Consumption	The total electrical power used by the entire airport.	Overall KPI	+					
Produced Electricity / Consumed Electricity	A comparison of the electricity generated on-site (possibly through solar panels or other means) to the amount consumed.	Overall KPI	+					
Overall Gas Consumption	Total gas usage by the airport, which could include heating or fuel for vehicles.	Overall KPI	+					
Overall Water Consumption	The sum of water used throughout the airport, important for managing utilities and sustainability efforts.	Overall KPI	+					
Gas Consumption per Pax	The amount of gas used, divided by the number of passengers, indicating the gas efficiency per passenger.	Overall KPI	+					

Electricity Consumption per Pax	The average electricity used per passenger, a measure of energy efficiency.	Overall KPI	+				
Water Consumption per Pax	The average water used per passenger, which can help in water conservation strategies.	Overall KPI	+				

2.4 Integration with other aviation systems and KPI's

Following KPI's will be gathered by some other aviation systems explained here.

Automatic Dependent Surveillance-Broadcast (ADS-B): Automatic Dependent Surveillance-Broadcast (ADS-B) is a state-of-the-art surveillance technology that enables aircraft to determine their position via satellite navigation and broadcast it, allowing it to be tracked. ADS-B improves safety, efficiency, and situational awareness for both air traffic controllers and pilots by providing accurate, real-time flight tracking information.

ATC (ATC Tower Management): Kule, or Air Traffic Control (ATC) Tower Management systems, are sophisticated solutions designed to support air traffic controllers in managing airport air space and ground traffic. These systems provide real-time data on aircraft positions, weather conditions, and air traffic communications, enhancing safety and efficiency in takeoff, landing, and taxiing operations.

Departure Control System (DCS): The Departure Control System (DCS) is a critical system used by airlines and airports to manage passenger check-in, boarding, and aircraft load planning. DCS ensures the smooth handling of passenger and flight information, from seat assignment and baggage processing to generating boarding passes and managing flight departures.

Load Control Messages (LDM): Load Control Messages (LDM) are key components in the exchange of information related to aircraft load and balance. LDMs provide essential data for safe and efficient aircraft operation, including details on passenger numbers, baggage weight, and cargo distribution, ensuring that aircraft are properly balanced for flight.

Collaborative Decision Making (CDM): Collaborative Decision Making (CDM) is a joint approach to air traffic management that involves various stakeholders, including airlines, airports, ground services, and air navigation service providers. CDM aims to improve air traffic efficiency by sharing real-time operational data, enhancing decision-making processes, and optimizing the use of resources.

Baggage Handling System (BHS): The Baggage Handling System (BHS) is an automated system designed to transport, sort, and track baggage from check-in to loading onto an aircraft and then to the baggage claim

area. BHS increases operational efficiency, reduces the chances of lost or misplaced luggage, and enhances the overall passenger experience.

Passenger and Traffic Management (PTM): Passenger and Traffic Management (PTM) systems are designed to optimize the flow of passengers and vehicles within the airport environment. These systems manage everything from passenger check-in and security screening to traffic congestion and parking facilities, aiming to streamline operations and improve the passenger journey.

Surface Movement Guidance and Control System (SMGCS): The Surface Movement Guidance and Control System (SMGCS) provides guidance to aircraft and vehicles on the airport surface during low visibility conditions and normal operations. It enhances safety by preventing runway incursions and ensuring efficient movement on runways and taxiways through a combination of control measures, lighting, and signage.

Ownership of the aforementioned aviation systems—AODB, ADS-B, ATC Tower Management (Kule), Departure Control System (DCS), Load Control Messages (LDM), Collaborative Decision Making (CDM), Baggage Handling System (BHS), Passenger and Traffic Management (PTM), and Surface Movement Guidance and Control System (SMGCS)—typically spans a variety of stakeholders within the aviation industry, each playing a pivotal role in the ecosystem. The AODB is usually owned and operated by the airport authority, serving as the central hub for operational data critical to airport management and operations. ADS-B, a surveillance technology for tracking aircraft, falls under the purview of national aviation authorities and air navigation service providers, who manage airspace safety and efficiency. The ATC Tower Management system is operated by air traffic control authorities, ensuring safe and orderly flow of air traffic. Departure Control Systems are typically owned by airlines or ground handling agents, facilitating passenger check-in and aircraft boarding processes. LDM, crucial for aircraft load and balance, is managed by airlines and their ground service partners. The CDM initiative involves a collaborative ownership model among airports, airlines, ground services, and air traffic management organizations to enhance operational efficiency through shared information. Baggage Handling Systems are owned by airport operators, designed to streamline baggage processing from check-in to aircraft loading. Passenger and Traffic Management systems are under airport authority jurisdiction, aiming to optimize passenger flow and vehicle traffic within airport premises. Lastly, SMGCS is usually owned by the airport authority, enhancing safety and efficiency of aircraft and vehicle movements on the airport surface, especially under low visibility conditions. This distribution of ownership and responsibility ensures that each aspect of airport and flight operations is efficiently managed by specialized entities, fostering an integrated approach to achieving safe, secure, and seamless travel experiences.

Name of Indicator	Description of Indicator	Type of Indicator	In Chart	Main Map	Sub-Map	In Map Direct	In Map Detail	Map Alert
AOBT Delay Alert	This KPI triggers an alert when the Actual Off-Block Time (AOBT), which is the time an aircraft leaves the gate, is later than planned. It's crucial for tracking the punctuality of flight departures.	Single KPI						+
Single Runway Status	This indicates the current operational status of a specific runway, whether it's active, closed, or has restrictions. It's a direct indicator of the runway's availability for takeoffs and landings.	Single KPI		+		+		
Single Runway Utilization	This measures how intensively a runway is being used. A high utilization rate can signal efficient use, whereas a low rate may indicate potential capacity that's not being utilized or operational issues.	Single KPI		+		+	+	
Average Taxi-Out Time (ATOT - AOBT) for Dep Runway	This is the average duration it takes for aircraft to taxi from the gate to the departure runway. It's calculated by subtracting the Actual Off-Block Time (AOBT) from the Actual Take-Off Time (ATOT), and is a measure of on-ground efficiency.	Overall KPI	+				+	
Average Taxi-In Time (ALDT - AIBT) for Arr Runway	This KPI calculates the average time it takes for aircraft to taxi from the arrival runway to the gate. It's determined by subtracting the Actual In-Block Time (AIBT) from the Actual Landing Time (ALDT). This is an important measure for assessing the efficiency of ground operations after landing.	Overall KPI	+				+	
Flights in Queue for Dep Runway and ETOTs	This KPI tracks the number of flights waiting for takeoff on a departure runway and their Estimated Take-Off Times (ETOTs). It can help manage runway traffic and anticipate delays.	Overall KPI					+	
Aircrafts in Queue for Arr Runway and ELDTS	Similar to the departure queue, this KPI monitors the number of aircraft waiting to land on an arrival runway and their Estimated Landing Times (ELDTs). This helps with managing landing traffic and adjusting arrival flows.	Overall KPI					+	

Average passenger processing time at single Gate (ASBT - ASRT)	The average time taken to process passengers at a single gate, from the Scheduled Boarding Time (ASBT) to the Start of Boarding Time (ASRT), is an operational efficiency measure for boarding procedures.	Single KPI					+	
Overall Carousel Capacities and Bag Utilizations	This KPI assesses the total baggage handling capacity of carousels and how much of this capacity is actually being used. This helps in identifying bottlenecks and planning for peak times.	Overall KPI	+					
Carousel Bag Distributions	This measures how evenly bags are distributed across all carousels. An uneven distribution can cause delays and congestion at some carousels while others are underutilized.	Overall KPI	+					
Overall Carousel Passenger Processing Time	This is the total time it takes for passengers to retrieve their luggage from carousels. It's a key metric for passenger satisfaction regarding baggage claim times.	Overall KPI	+					
Carousel Passenger Processing Time Distribution per Carousel	This breaks down the baggage claim times by each individual carousel, identifying specific carousels that may be underperforming and causing delays.	Overall KPI	+					
Carousel Passenger Processing Time Distribution per Airline	This KPI analyzes the time it takes for passengers from different airlines to retrieve their luggage at the baggage carousel. It can help identify if delays are specific to certain airlines, which could be due to factors like baggage handling agreements or the timing of baggage offloading.	Overall KPI	+					
Carousel Status	This indicates the current operational condition of each baggage carousel, such as whether it is operational, under maintenance, or out of service. This helps in managing passenger expectations and reassigning resources if necessary.	Single KPI				+		
Single Carousel Bag Utilization	This measures how much of a single carousel's capacity is being used for baggage. It is important for ensuring that no single carousel is overburdened, which could lead to delays in baggage retrieval and passenger dissatisfaction.	Single KPI					+	

PRM Flow Monitoring	This involves tracking and managing the flow of Passengers with Reduced Mobility (PRM) through the airport to ensure they receive the necessary assistance in a timely manner and have a smooth transit experience.	Overall KPI				+		
Passenger Distribution per Age	This KPI provides data on the age distribution of passengers within the airport. It is useful for tailoring services and facilities to the needs of different age groups, such as play areas for children or seating arrangements for elderly passengers.	Overall KPI	+					
Passenger Distribution per Gender	This KPI helps in understanding the gender proportion of passengers at the airport, which can be important for facilities planning, such as restrooms, and for marketing purposes.	Overall KPI	+					
Passenger Distribution per Nationality	This KPI offers insights into the nationality breakdown of passengers. It is valuable for cultural and language services planning, as well as for duty-free sales strategies.	Overall KPI	+					
In-block Delay Distribution [SIBT - AIBT]	This measures the distribution of delays between the Scheduled In-Block Time (SIBT) and the Actual In-Block Time (AIBT), offering insights into the punctuality of flights arriving at the gate.	Overall KPI	+					
Taxi In On-Time Distributions per Flights	This KPI shows the proportion of flights that achieve their taxi-in times within a set standard, which is an important aspect of on-time performance for arriving flights.	Overall KPI	+					
Average Taxi In Time of Flights	This is the average time that aircraft take to taxi from the runway to the gate after landing. It's a crucial metric for assessing the efficiency of ground operations post-landing.	Overall KPI	+					
Average Taxi In Time Distributions per Airline	This KPI analyzes the average taxi-in times across different airlines, which can help identify whether certain airlines are consistently experiencing longer taxi-in times.	Overall KPI	+					

Average Taxi In Time Distributions per AC Type	This KPI breaks down the average taxi-in times by aircraft type, acknowledging that different aircraft may have varying taxi speeds and requirements.	Overall KPI	+					
Taxi in On-Time / Taxi in Delay	This KPI compares the number or proportion of flights that taxi into the gate on time versus those that experience a delay, giving a direct measure of operational efficiency for arrivals.	Overall KPI	+					
Average Taxi Out Time	This measures the average time taken for aircraft to taxi from the gate to the runway for departure. It is a key factor in determining the overall efficiency of the airport's ground operations and its effect on flight punctuality.	Overall KPI	+					
Average Off-Block Delays [SOBT - AOBT]	This KPI measures the average delay between Scheduled Off-Block Time (SOBT) and Actual Off-Block Time (AOBT). A high average indicates that flights are regularly departing later than scheduled from the gate.	Overall KPI	+					
Taxi-Out Time Distributions per Flights	This distribution shows the variability of taxi-out times across all flights, identifying any inconsistencies or outliers in how long it takes aircraft to reach the departure runway from the gate.	Overall KPI	+					
Average Taxi-Out Time of Flights	This is the average time that it takes for all departing flights to taxi from the gate to the runway. It's an important indicator of the efficiency of the airport's ground operations	Overall KPI	+					
Taxi-Out Time Distributions per Airline	This KPI provides insight into how the taxi-out times vary among different airlines, which could be influenced by their specific operations, procedures, and times of operation.	Overall KPI	+					
Taxi-Out Time Distributions per AC Type	Different types of aircraft (AC Type) may have different taxi-out times due to their size, speed, and handling characteristics. This KPI helps to understand these differences.	Overall KPI	+					

Taxi-Out Time Distributions per GHS	The distribution of taxi-out times can also be analyzed based on the ground handling service (GHS) provider, revealing the efficiency of different ground handlers.	Overall KPI	+					
Taxi-Out Time Distributions per Flight Service Type	This KPI examines the taxi-out time for different types of flights, such as commercial, cargo, or charter, which might have different operational priorities and constraints.	Overall KPI	+					
Taxi-Out in Time / Taxi-Out in Delay	This ratio or distribution measures how many flights taxi out on time as opposed to those that are delayed. It's a direct measure of on-time performance for the taxi-out phase.	Overall KPI	+					
Average ARDT Delays	Aircraft Ready for Departure Time (ARDT) delays are measured to see how often aircraft are not ready by the expected time. This can be due to a variety of operational factors.	Overall KPI	+					
Average ASRT Delays	The delay in Actual Start-Up Request Time (ASRT), the point at which the pilot requests permission to start the engines or push back, is averaged here. Delays could indicate issues with gate readiness or ground services.	Overall KPI	+					
Average ASRT - ARDT Difference	This KPI measures the average time between when an aircraft is ready (ARDT) and when the pilot actually requests start-up (ASRT), highlighting potential inefficiencies in communication or process.	Overall KPI	+					
Average ARDT - AOBT Difference	This KPI shows the average difference between the time the aircraft is ready for departure and the actual off-block time. A large difference could indicate delays in pushback or ground handling services.	Overall KPI	+					
Average Push Delays [AOBT-ASAT]	The average delay between the Actual Off-Block Time (AOBT) and the Actual Start-Up Approval Time (ASAT), which is the time when the aircraft is cleared to start the engines and begin pushback.	Overall KPI	+					

Push Delays [AOBT-ASAT] Distribution per Airlines	This KPI breaks down the distribution of pushback delays by airline, which could help identify if certain airlines are experiencing more pushback delays than others.	Overall KPI	+					
Push Delays [AOBT-ASAT] Distribution per AC Types	This metric examines the distribution of pushback delays sorted by aircraft types. Larger or more complex aircraft might have longer push delays due to additional preparations required.	Overall KPI	+					
Push Delays [AOBT-ASAT] Distribution per GHS	This KPI breaks down the pushback delay times based on the Ground Handling Services (GHS) providers. It helps identify which GHS companies are experiencing more delays, potentially indicating issues with processes or staffing.	Overall KPI	+					
TSAT vs ASAT Compliance	This compares the Target Start-Up Approval Time (TSAT) with the Actual Start-Up Approval Time (ASAT). It measures compliance with the planned pushback times, which is critical for maintaining the airport's overall departure schedule.	Overall KPI	+					
CTOT Compliance	Calculated Take-Off Time (CTOT) compliance measures how often flights take off at their calculated take-off times. High compliance indicates good coordination between airport operations and air traffic control.	Overall KPI	+					
TTOT ATOT Compliance	This refers to the compliance with Target Take-Off Time (TTOT) and Actual Take-Off Time (ATOT). It measures the effectiveness of an airport's scheduling and the ability to adhere to planned take-off times.	Overall KPI	+					
CDM Milestone View	Collaborative Decision Making (CDM) involves various stakeholders in the air traffic management process. This KPI provides a view of different CDM milestones, assessing how well the airport and its partners are working together to manage air traffic.	Overall KPI	+					
Total Missed or Damaged Baggage Count	This is the total number of bags that have either been missed (not loaded onto the correct flight) or damaged during handling processes. It's a critical measure of baggage handling performance.	Overall KPI	+					

Missed or Damaged Baggage Count Distribution per Passenger Count for GH Companies	This KPI shows the distribution of missed or damaged bags relative to the number of passengers handled by different ground handling companies. It's useful for assessing the performance and reliability of each GHS provider.	Total KPI	+					
Missed or Damaged Baggage Count Distribution per GH Companies	This KPI measures how many bags were missed or damaged by each ground handling company. It is used to evaluate the performance of the baggage handling services provided by different companies.	Total KPI	+					
Missed or Damaged Baggage Count Distribution per Passenger Count for Airlines	This KPI assesses the ratio of missed or damaged bags to the number of passengers for each airline. It can help airlines to gauge their baggage handling performance relative to the size of their operation.	Total KPI	+					
Missed or Damaged Baggage Count Distribution per Airlines	This metric provides the distribution of missed or damaged bags across different airlines, regardless of passenger count. It allows for a direct comparison of baggage handling issues between airlines.	Total KPI	+					
Missed or Damaged Baggage Count Distribution per Arrival / Departure	This KPI differentiates between baggage issues occurring on arriving flights versus departing flights, helping to pinpoint where in the travel process the baggage handling problems are most prevalent.	Total KPI	+					
Missed or Damaged Baggage Count Distribution per Int / Dom	This metric compares the count of missed or damaged baggage between international and domestic flights. It can reveal if one segment has more issues than the other, which may be due to different handling procedures or transit times.	Total KPI	+					

Missed or Damaged Baggage Count Distribution per Transfer / Regular	This KPI examines how missed or damaged baggage incidents are distributed between transfer passengers and those on regular flights. Transfer baggage is typically more prone to issues due to the complexities involved in moving bags between flights.	Total KPI	+					
Missed or Damaged Baggage Count / Handled Baggage Count per GH Companies	This ratio shows the number of missed or damaged bags relative to the total number of bags handled by each ground handling company. It provides a performance metric that accounts for the volume of work each company does.	Total KPI	+					
Missed or Damaged Baggage Count / Handled Baggage Count per Airlines	Similar to the above, this ratio gives the number of missed or damaged bags relative to the total number of bags handled per airline. It allows airlines to assess their baggage handling efficiency.	Total KPI	+					
Average Arrival Baggage Processing Times Distribution per Bridge for GH Companies	This KPI measures the average time taken to process arrival baggage at jet bridges for each ground handling company. It helps identify efficiency differences in baggage unloading and delivery to the carousel.	Total KPI	+					
Average Departure Baggage Processing Times Distribution per Bridge for GH Companies	This metric assesses the average time ground handling companies take to process departure baggage at the gate bridges, which impacts the on-time departure of flights.	Total KPI	+					
Average Arrival Baggage Processing Times Distribution per Remote for GH Companies	This KPI measures how long it takes for ground handling companies to process arriving baggage from remote stands, which may not be directly connected to the terminal.	Total KPI	+					

Average Departure Baggage Processing Times Distribution per Remote for GH Companies	This metric tracks the average time to process departure baggage from remote stands by ground handling companies, which can be more challenging due to the distance from the terminal.	Total KPI	+					
Average Arrival Baggage Processing Times Distribution per AC Cat for GH Companies	This measures the average time it takes for ground handling companies to process arriving luggage based on the category of the aircraft (AC Cat). Different aircraft types may require varying handling times due to size, luggage capacity, and configuration.	Total KPI	+					
Average Departure Baggage Processing Times Distribution per AC Cat for GH Companies	Similar to arrival processing, this KPI measures the average time ground handling companies take to process departure luggage by aircraft category, which is important for ensuring timely baggage loading and flight departures.	Total KPI	+					
Average Arrival Baggage Processing Times Distribution per Pax Count for GH Companies	This KPI tracks the average time it takes to process arrival baggage as a function of passenger count for each flight. It helps in understanding how passenger volume affects baggage handling times.	Total KPI	+					
Average Departure Baggage Processing Times Distribution per Pax Count for GH Companies	This metric analyzes how the number of passengers affects the average time needed by ground handlers to process baggage for departure.	Total KPI	+					

Average Arrival Baggage Processing Times Distribution per Bridge for Airlines	This KPI assesses the average time airlines take to deliver arriving baggage to passengers at the bridge. It can help airlines monitor the efficiency of their baggage operations at the terminal.	Total KPI	+					
Average Departure Baggage Processing Times Distribution per Bridge for Airlines	This measures the average time taken by airlines to process departure baggage at the gate bridges. It's crucial for on-time departures and efficient turnarounds.	Total KPI	+					
Average Arrival Baggage Processing Times Distribution per Remote for Airlines	This KPI tracks the average time airlines take to process arriving baggage at remote stands, which often requires additional transportation to the terminal.	Total KPI	+					
Average Departure Baggage Processing Times Distribution per Remote for Airlines	This measures how long it takes for airlines to process departure baggage at remote stands, which can impact the departure punctuality for flights not directly connected to the terminal.	Total KPI	+					
Average Arrival Baggage Processing Times Distribution per AC Cat for Airlines	This metric breaks down the average baggage processing times upon arrival by aircraft category for airlines. It reflects how the type of aircraft may impact the speed of baggage service delivery.	Total KPI	+					
Average Departure Baggage Processing Times Distribution per AC Cat for Airlines	This KPI measures the average time airlines take to process departure baggage, categorized by the type of aircraft. It's useful for identifying if certain aircraft types are associated with baggage handling delays.	Total KPI	+					

Average Arrival Baggage Processing Times Distribution per Pax Count for Airlines	This KPI examines the average time taken by airlines to process arriving baggage relative to the number of passengers on the flight, providing insights into how well airlines handle baggage operations under different load conditions.	Total KPI	+					
Average Departure Baggage Processing Times Distribution per Pax Count for Airlines	This measures how passenger volume affects the average time airlines need to process departure baggage, an important aspect of managing boarding and departure times.	Total KPI	+					
Overall Baggage Processing Performance Distribution per GH Companies	This KPI assesses the overall efficiency and effectiveness of baggage handling across all flights by different ground handling companies. It gives a comprehensive view of each company's performance.	Total KPI	+					
Overall Baggage Processing Performance Distribution per Airlines	This metric provides an overview of how well each airline is managing baggage processing, taking into account all flights and all stages of baggage handling.	Total KPI	+					
Overall Arrival Baggage Processing Performance of Airport	This KPI measures the airport's effectiveness in processing arriving passengers' baggage, from the point of unloading from the aircraft to the baggage claim area.	Total KPI	+					
Overall Departure Baggage Processing Performance of Airport	This metric evaluates the airport's efficiency in handling baggage from check-in counters through to loading onto departing flights.	Total KPI	+					
Overall Transfer Baggage Processing Performance of Airport	This assesses the airport’s efficiency in handling transfer baggage, which requires moving bags between different flights, often within tight time frames.	Total KPI	+					

Total Transferred Baggage Weight Distribution per GH Companies	This KPI tracks the weight of transfer baggage handled by each ground handling company, providing insights into their workload and capacity for handling transfer baggage operations.	Total KPI	+					
Total Transferred Baggage Weight Distribution per Airlines	This metric shows the distribution of total weight for transferred baggage across different airlines, which can be used to evaluate and manage the airlines' handling of transfer baggage.	Total KPI	+					
Average PRM Departure Waiting Time Distribution per GH Companies	This KPI calculates the average waiting time that Passengers with Reduced Mobility (PRM) experience before departure, broken down by the ground handling companies responsible for assisting them.	Total KPI	+					
Average PRM Arrival Waiting Time Distribution per GH Companies	Similar to departure waiting times, this KPI measures the average waiting time for PRMs upon arrival, distributed among the different ground handling companies.	Total KPI	+					
Average PRM Departure Waiting Time Distribution per Airlines	This metric indicates the average waiting time for PRMs departing on various airlines, helping to identify which airlines are providing timely assistance to PRMs.	Total KPI	+					
Average PRM Arrival Waiting Time Distribution per GH Airlines	This measures the average waiting time for PRMs arriving on flights operated by different airlines, which reflects on the airlines' service levels for PRMs.	Total KPI	+					
Average Arrival PRM Processing Time of Airport	This KPI measures the average time taken by the airport to process PRMs from the point of arrival to when they receive all necessary assistance.	Total KPI	+					

Average Departure PRM Processing Time of Airport	This metric tracks the average time it takes for the airport to assist PRMs from their arrival at the airport to their departure, including check-in, security, and boarding.	Total KPI	+					
PRM Long Waiting Alert Count Distribution per GH Companies	This counts the number of alerts triggered when PRMs experience longer than acceptable waiting times, categorized by ground handling companies.	Total KPI	+					
PRM Long Waiting Alert Count Distribution per Airlines	This KPI counts the number of alerts for PRMs who have waited too long, sorted by airlines. It is used to monitor and improve the service quality provided to PRMs.	Total KPI	+					

2.5 Integration with other building systems

Closed-Circuit Television (CCTV) systems are a cornerstone in modern security and surveillance operations, extensively used across a wide range of settings, from public spaces and commercial establishments to private residences and governmental facilities. These systems consist of video cameras that capture visual footage of their surroundings, which is then transmitted to a private network for monitoring, recording, and analysis. The primary purpose of CCTV systems is to enhance security, deter criminal activities, facilitate real-time surveillance, and provide recorded evidence for investigative purposes. With advancements in technology, modern CCTV systems have evolved to include high-definition video capture, remote monitoring capabilities via the internet, motion detection, and integration with other security systems like access control and alarms, offering comprehensive security solutions.

The data generated and stored by CCTV systems primarily include:

- Video Footage: The core data consists of continuous or motion-triggered video recordings that capture activities within the camera's field of view. This footage is crucial for monitoring purposes, post-event analyses, and as evidence in legal proceedings.
- Timestamps: Every piece of video footage is accompanied by precise timestamps, which are critical for tracking when specific events occur. Timestamps facilitate easy navigation through recorded data to find relevant events or activities.
- Metadata: Alongside visual data, CCTV systems can generate metadata, which includes information about the video file format, camera settings (e.g., resolution, frame rate), and camera location identifiers. This metadata is essential for managing and processing video data efficiently.

- Analytics Data: Advanced CCTV systems equipped with video analytics capabilities can generate additional data types, such as motion patterns, heat maps (showing areas of high activity), facial recognition data, license plate numbers, and object identification. This data helps in enhancing security measures, understanding traffic flows, and identifying trends or anomalies in monitored environments.
- Alerts and Notifications: Systems configured with motion detection or other analytic functions can generate alerts or notifications in response to specific triggers, such as unauthorized access or movement in restricted areas. These alerts contain information about the nature of the event and its location, enabling quick response to potential security incidents.

The CCTV system is a system used by the Police, from which we cannot obtain images. However, throughout the project duration, we aim to engage with the Police and plan to transfer AI outputs to the SOCFAI platform, even without the images, by preparing an AI solution for them.

Flight Information Display Systems (FIDS) are integral to modern airports, serving as the primary means of communicating real-time flight information to passengers, airport staff, and visitors. These systems are ubiquitous throughout airport terminals, strategically placed in areas like check-in counters, gate areas, baggage claim zones, and entrance lobbies. FIDS play a crucial role in enhancing passenger experience by providing up-to-date flight details, thereby facilitating smooth airport navigation and minimizing confusion or delays.

The data presented in FIDS encompass a wide array of flight-related information crucial for passengers and airport operations alike. This includes:

- Flight Schedules: Detailed listings of departure and arrival times, ensuring passengers are informed about the timing of their flights.
- Gate Information: Information on gate assignments for boarding, helping passengers find their way to the correct departure area.
- Flight Status: Real-time updates on flight status, including boarding calls, delays, cancellations, and early or on-time departures and arrivals.
- Baggage Claim Information: Details on baggage claim areas or belts where passengers can collect their luggage upon arrival.
- Check-in Counter Details: Information regarding check-in counter numbers or areas for specific flights, aiding passengers in starting their journey smoothly.
- Security and Customs Information: Updates that may include wait times or changes in procedures at security checkpoints and customs areas, helping passengers to plan accordingly.
- Airline Announcements: Any airline-specific messages, including changes in boarding procedures, loyalty program updates, or services available at the airport.
- Emergency Information and Instructions: In the event of an emergency, FIDS can also be used to display critical instructions or directions to ensure passenger safety.

Enterprise Resource Planning (ERP) systems represent a comprehensive suite of integrated applications designed to streamline and automate core business processes, enhancing operational efficiency, and providing strategic data insights across an organization. By centralizing data from various departments,

including finance, human resources, production, procurement, and sales, ERP systems facilitate improved decision-making, resource management, and operational visibility. These systems are pivotal for organizations looking to optimize their workflows, reduce operational costs, and foster collaborative efforts among different business units by breaking down silos and ensuring a unified approach to achieving business objectives.

The data housed within an ERP system is extensive and varied, reflecting the diverse processes and functions it manages. Key categories of data include:

- Financial Data: This encompasses all financial transactions, budgeting, accounting records, and reports, such as balance sheets, income statements, cash flows, and ledgers, providing a comprehensive view of the organization's financial health.
- Human Resources Data: Information related to employee management, including recruitment, salaries, benefits, performance evaluations, and personal records, which aids in workforce planning and optimization.
- Supply Chain Data: Details of procurement, inventory levels, order fulfillment, supplier management, and logistics, enabling effective supply chain coordination and management.
- Customer Data: Comprehensive customer information, including contact details, purchase history, feedback, and service requests, which supports sales management, customer relationship management (CRM), and marketing strategies.
- Production and Manufacturing Data: Data on production planning, product lifecycle management, manufacturing processes, quality control, and maintenance schedules, which is crucial for manufacturing efficiency and product management.
- Project Management Data: Information related to project planning, resource allocation, timelines, budgeting, and progress tracking, facilitating project execution and monitoring.

For car park measurements, there is not any system exist in ADB airport yet but during the project, TAV technology will try to develop an alternative for it.

Name of Indicator	Description of Indicator	Type of Indicator	In Chart	Main Map	Sub-Map	In Map Direct	In Map Detail	Map Alert
Overall Parking Area Capacity and Utilizations	This KPI measures the total number of parking spaces available across all parking areas and the percentage of those spaces currently being used. It's critical for understanding parking availability and managing parking resources efficiently.	Single KPI				+		
Parking Area Car Distributions per Zones	This KPI breaks down the number of cars parked in each zone of the parking area. It can help identify which zones are most frequently used and might require additional services or maintenance.	Overall KPI	+					
Parking Area Status	This indicates the current operational status of the parking areas (e.g., open, full, closed for maintenance). It helps both staff and visitors understand where parking is available.	Overall KPI	+					
Single Parking Area Utilizations	This KPI measures the utilization of individual parking areas. It's used to determine the usage patterns of specific lots or garages, which can inform decisions about pricing, promotions, or expansions.	Single KPI		+		+		
Camera Status	This indicates whether individual security cameras are operational, offline, obstructed, or require maintenance. It's crucial for maintaining security and surveillance capabilities.	Single KPI		+		+		
Overall Camera Status	This provides a comprehensive view of the security camera network's status across the facility, giving a quick overview of the surveillance system's health and coverage.	Single KPI		+		+		
Real Time Camera Footage	This refers to the live video feed being captured by the security cameras. Monitoring real-time footage is essential for security operations, allowing for immediate response to incidents.	Overall KPI	+					

Overall Costs per Passengers	This KPI calculates the average cost incurred per passenger, which can include all operational costs divided by the number of passengers. It's a broad measure of operational efficiency and cost management	Single KPI					+	

3. Airport Prediction Requirements

Creating predictive models from the vast array of data available in aviation systems offers significant benefits to airport operations, enhancing efficiency, safety, and passenger satisfaction. Here's how specific data systems contribute to various prediction models and the advantages these predictions bring:

Weather Data Systems:

- De-Icing Predictions: Utilize weather forecasts to predict the need for aircraft de-icing, optimizing de-icing resource allocation and minimizing delays.
- Wind Directions and Speeds, Visual Range, Air Temperature, Air Pressure, Cloud Height Predictions: Forecast crucial weather conditions affecting flight operations and safety, enabling better flight planning and airport operations adjustments.

Flight Operations Systems (AODB, ADS-B):

- ATOT, ALDT, ASBT, ASRT, Arrival and Departure Delay Predictions: Analyze historical flight data to forecast delays, improving scheduling, resource allocation, and passenger communication.
- CDM Milestone, Flight Diversion Predictions: Leverage collaborative data sharing platforms for predicting operational milestones and potential flight diversions, enhancing coordinated decision-making and preparedness.

Passenger Processing Systems (DCS, BHS):

- Counter Queue, BC Queue, SC Queue Predictions: Utilize passenger flow and flight schedule data to predict queue lengths, optimizing staff allocation and reducing passenger wait times.
- First Bag, Last Bag Delay Predictions: Analyze baggage handling speeds and flight data to estimate baggage delivery times, improving passenger experience and resource planning.

Facility Management Systems:

- Carousel, Lounge, Parking Area Utilization Predictions: Use historical usage data to forecast crowd sizes and parking demand, guiding resource allocation, and facility management strategies.
- Electricity, Gas, Water Consumption Predictions: Predict utility consumption based on operational data, aiding in cost management and sustainability efforts.

Special Needs Passenger Management Systems:

- PRM Flow Predictions: Analyze data on passengers with reduced mobility to forecast service needs, ensuring adequate assistance and smooth operations.

Overall Airport Operations Data:

- Overall Passenger Arrival, Passenger Count Predictions: Utilize passenger booking and historical flow data to estimate total passenger numbers, crucial for staffing, security, and facility management.

- In-block Delay, Departure Delay, and Overall Service Predictions: Leverage integrated airport operational data to predict various delays, optimizing gate assignments, ground handling, and passenger services.

The benefits of these predictions to operations include:

- Enhanced Operational Efficiency: By accurately forecasting operational demands, airports can allocate resources more effectively, reducing waste and improving service delivery.
- Improved Passenger Experience: Predictive models enable airports to manage passenger flows smoothly, reducing wait times, and improving satisfaction.
- Increased Safety and Security: Forecasting adverse conditions and potential disruptions allows for proactive measures to ensure safety and security.
- Cost Savings and Sustainability: Efficient resource utilization, informed by predictive analytics, can lead to significant cost savings and reduced environmental impact.
- Strategic Planning: Long-term forecasts support strategic decision-making, facility expansion, and technology investments, ensuring airports remain competitive and capable of handling future demands.

By integrating and analyzing data from these diverse systems, airports can build a resilient operational model that anticipates challenges, optimizes resource use, and enhances the overall airport ecosystem.

Name of Indicator	Description of Indicator
De-Icing Predictions from Weather Data	Forecasting the likelihood of aircraft de-icing needs based on anticipated weather conditions.
ATOT Delay Predictions	Predictions of delays in Actual Take-Off Time, indicating potential departure delays.
ALDT Delay Predictions	Forecasts of delays in Actual Landing Time, used to anticipate and manage arrival delays.
ASBT Delay Predictions	Estimations of delays in Actual Scheduled Boarding Time, affecting the boarding process.
ASRT Delay Predictions	Predictions of delays in Actual Start-Up Request Time, when an aircraft requests to start engines or push back.
Counter Queue Predictions (Passenger Arrival	Forecasts of passenger queue lengths at counters, aiding in staff allocation and management.
First Bag, Last Bag Delay Predictions	Estimating times for the first and last bags to arrive on the carousel, affecting passenger wait times.

Carousel Crowd Predictions	Predicting the number of passengers around baggage carousels, to manage crowd control and staffing.
Lounge Crowd Predictions	Estimations of crowd sizes in airport lounges, for resource and capacity planning.
BC Queue Predictions (Passenger Arrival	Forecasts of passenger queues at border control counters.
SC Queue Predictions (Passenger Arrival	Predictions of queue lengths at security control, including check-in and information desks.
Parking Area Utilization Predictions	Estimations of car park usage rates, for management and pricing strategies.
Wind Directions and Speeds Predictions	Forecasting wind conditions, which are crucial for flight operations and safety.
Visual Range Predictions	Estimating visibility distances, important for landing and takeoff decisions.
Air Temperature Predictions	Predicting temperatures, affecting aircraft performance and de-icing requirements.
Air Pressure Predictions	Forecasting air pressure levels, which can affect flight planning and operations.
Cloud Height Predictions	Estimations of cloud ceilings, important for visual flight rules.
Electricity Consumption Predictions	Predicting the airport's power usage, for cost management and sustainability efforts.
Overall Gas Consumption Predictions	Estimating gas usage, affecting heating and operational costs.
Overall Water Consumption Predictions	Forecasting water use, crucial for resource management.
PRM Flow Predictions	Predicting the flow and needs of Passengers with Reduced Mobility, for adequate service provision.
Overall Passenger Arrival Predictions	Estimating the total number of arriving passengers, affecting staffing and resource allocation.

Passenger Count Predictions for Entire Airport	Forecasting the total passenger traffic, important for overall airport operations planning.
Arrival Delay Predictions, AIBT, ALDT	Predicting delays in Actual In-Block Time and Actual Landing Time, for operational planning.
In-block Delay Prediction	Estimating the delays of aircraft reaching their parking stands after landing.
Departure Delay Predictions ARDT, ASRT, AOBT, ATOT,	Forecasting various departure-related delays, including aircraft readiness, start-up request, off-block, take-off, and pushback times.
CDM Milestone Predictions	Predicting the timings of Collaborative Decision-Making milestones, essential for integrated airport operations.
Flight Diversion Prediction	Estimating the likelihood of flights being diverted, crucial for operational readiness and passenger management.

4. Scenario Specific Platform Requirements

This comprehensive set of requirements outlines the foundation for a sophisticated, integrated system designed to enhance operational efficiency, passenger experience, and environmental sustainability within an airport ecosystem. Central to this system is the deployment of a dockerized solution, ensuring platform-independent architecture that enables seamless deployment and scalability across different computing environments. The inclusion of an SQL server for robust data storage underpins the system's core, facilitating the secure and efficient management of critical operational data.

Key components of the system include APIs for gathering and analyzing baggage and flight information, alongside real-time dashboards for immediate data visualization and decision-making support. The system extends its analytical capabilities to social media, with APIs dedicated to tracking and analyzing posts and sentiments, thereby enabling a comprehensive understanding of passenger sentiment. This data, crucial for enhancing passenger satisfaction, will be directly integrated with Tav Tech solutions.

Further augmenting the system's capabilities is the innovative use of demo Lidar sensors for advanced people counting and flow management within airport terminals. This information not only aids in optimizing passenger movement and safety but also enriches the data pool available for analytics. User authentication and key management for API integration ensure secure access, maintaining the integrity and confidentiality of data exchanges.

The asset overview dashboard provides a real-time view of all connected assets, facilitating efficient asset management and operational oversight. Integration with local energy systems introduces an environmental dimension, allowing for the monitoring of electricity prices and supporting sustainable energy use. Simplified access to data and system functionalities is achieved through a single-point REST API, bulk data export API, and command API, streamlining interactions and enhancing system usability.

Supporting the backend infrastructure, a message broker and a distributed event streaming platform enable the efficient handling of IoT messages and real-time data feeds, ensuring high throughput and low latency. The data analytics engine offers powerful processing capabilities for large-scale data, while scalable data storage units provide flexible, distributed storage solutions tailored for search and analytics use cases. Finally, a data visualization tool specifically for air quality data underscores the system's commitment to environmental monitoring and sustainability.

Together, these components form a robust, integrated system designed to meet the dynamic needs of modern airport operations, from enhancing passenger experiences and operational efficiency to supporting environmental sustainability initiatives.

Requirement	Description	Owner	Importance (H,M,S)	Storage	Integration	Management	Functional
Dockerized solution for platform-independent architecture	An architecture with docker containers for platform-independence.	Siemens	H		O	O	O
SQL server for data storage	A database for internal data storage.	Siemens	H	O		O	
Baggage & flight data gathering and analytics API	An API for gathering baggage and flight information.	Siemens	H	O	O		
Real Time Dashboard	A dashboard to display real-time data and analytics for the baggage handling system.	Siemens	H	O		O	O
Social media analytics API	An API for tracking social media posts and sentiments.	Inosens	H				O
Tracking passenger sentiment	Track the social media sentiments and pass them to Tav Tech.	Inosens	M				O
Installation of demo Lidar sensors	Install Lidar sensors in the airport terminal for people counting and flow management.	Inosens	M				O
Distributing Lidar information	Passing Lidar flow information to Tav Tech.	Inosens	H				O
Credential Authentication	User authentication and key management for API Integration	Enverse	H		O	O	O
Asset Overview Dashboard	Real time dashboard for overall connected asset/authorised assets for API Reference.		S		O	O	
Local Energy System Integration	Integration with real-time data from local energy system showing wholeale electricity price.	Enverse	M		O		O
Single Point Rest API	A single URL endpoint rest API for data request from SOCFAI	Enverse	H		O		
Bulk data export API	A single API request for bulk data export. The response will return a specific url for downloading the CSV file when the file is generated. The response will also contain bulk data export progress.	Enverse	H	O	O		

Command API	A single URL endpoint for Energy Prediction System to issue control command.	Enverse	H		O	O	O
Webhook API	A Single webhook API for Energy Prediction System to export forecasted data to SOCFAI.	Enverse	H		O	O	O
Message Broker	Software module to get IOT messages in http, mqtt or coap protocol	Netas	H		O		
Distributed Event Streaming platform	Unified, high-throughput, low-latency platform for handling real time data feeds	Netas	H				O
Data Analytics Engine	Unified analytics engine for large scale data processing	Netas	H				O
Scalable Data Storage Unit	Distributed, document-oriented database for search and analytics use cases	Netas	H	O			
Data Visualization Tool	Visualization of air quality data	Netas	H				O

5. Airport Scenario Visualization Requirements

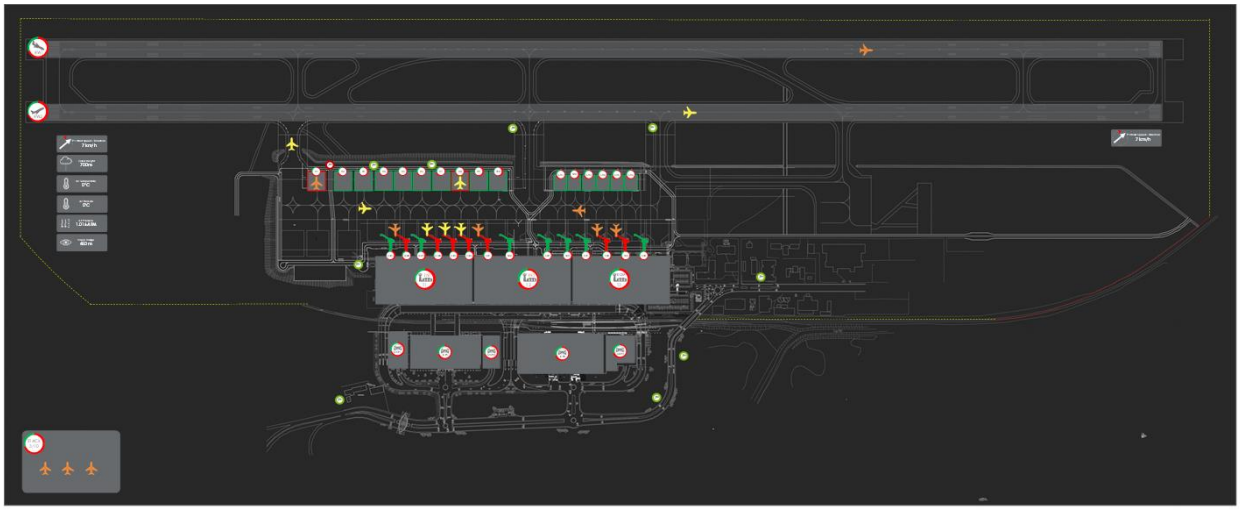


Figure 2 - Airport Map Top Layer

The map application should be developed in a way that allows users to view all operational issues and processes from a single point. When users look at the top layer of the airport map, they should be able to see runway occupancy, real-time runway status, occupancy and real-time status of remote and bridge stands, terminal occupancy, parking lot occupancy, weather information, and flights waiting to land.

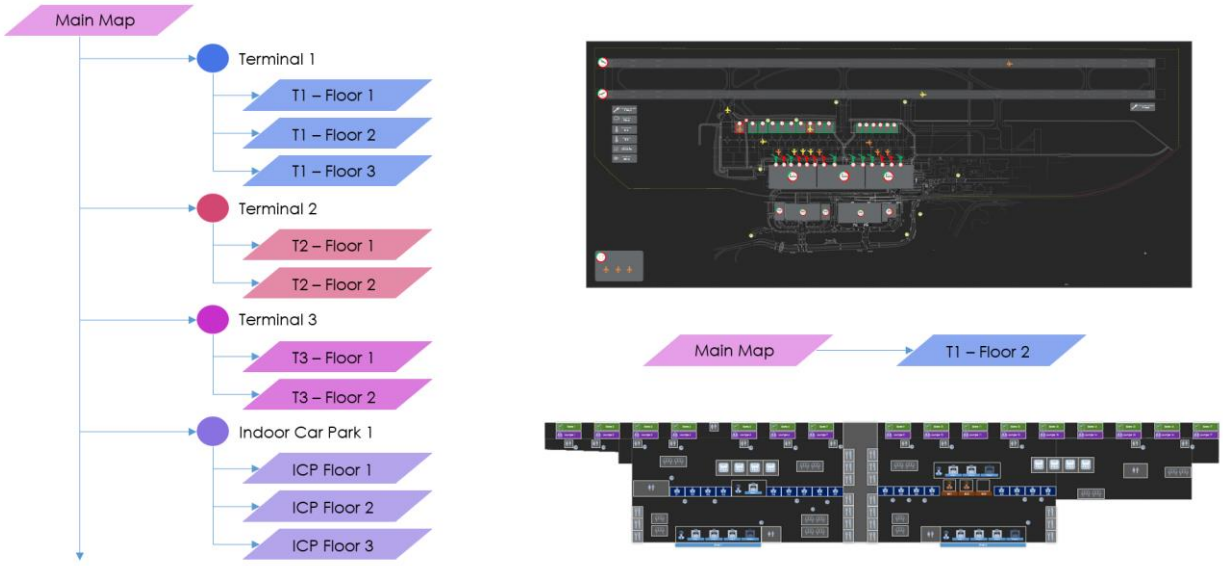


Figure 3 - Layers of Airport Map

Users should be able to drill down from the top layer to lower layers to follow operational processes in different terminal floors and view details not shared on the top layer.

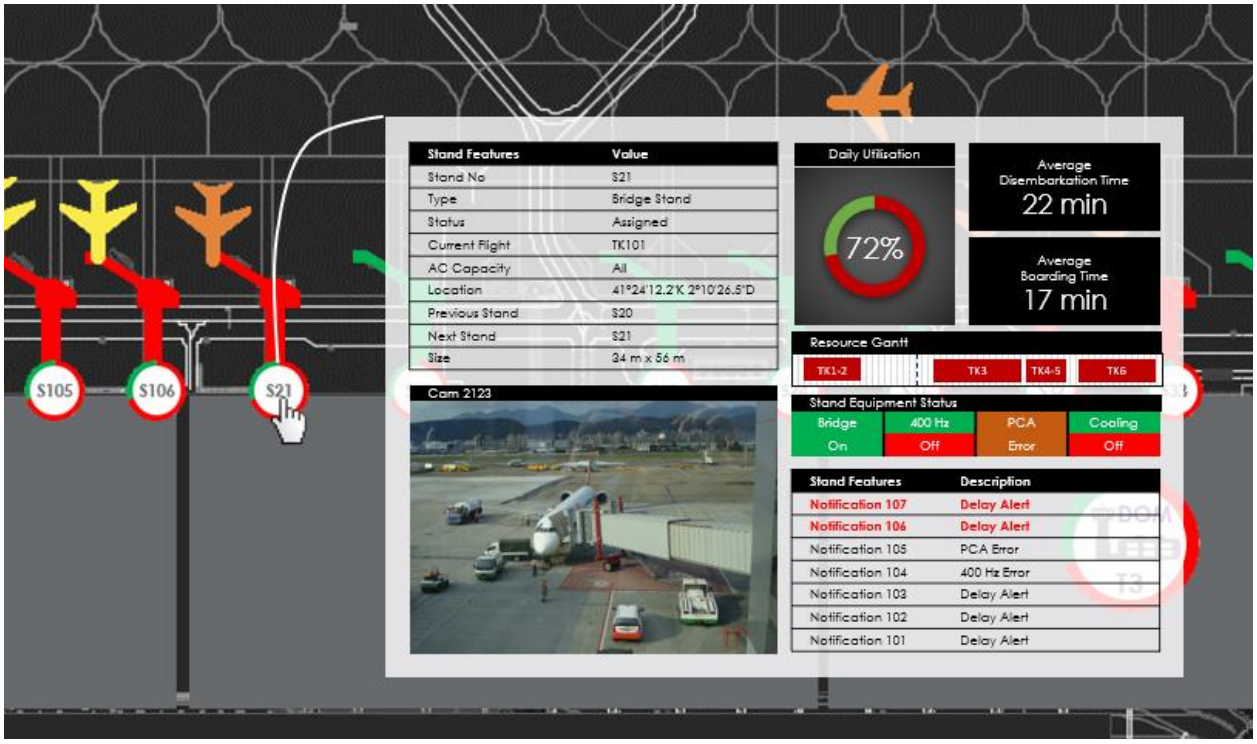


Figure 4 - Bridge Stand Details

When users click on a bridge stand or other objects on the map, they should be able to access information such as the daily utilization of parking spaces, average times for boarding and deboarding

passengers, information on other flights that will arrive at the parking space later in the day, and the real-time statuses of equipment located at the parking space.

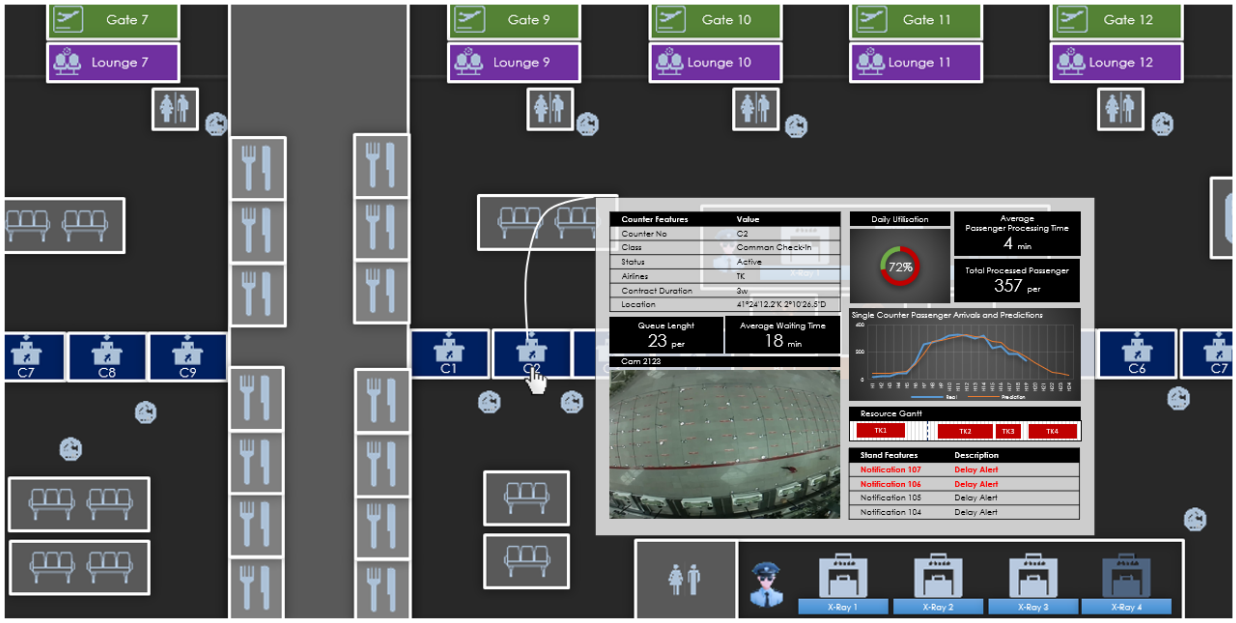


Figure 5 – Terminal Map

Upon entering the lower layers, users should be able to view the KPIs of detailed operations. Moreover, having features like alerts, zooming, and pinning popups within the map application would be beneficial.

Figure 6 - Dashboard Example

Platform users should be able to create their own dashboards using the map and related KPIs. Additionally, the viewing application should provide the following features:

- Creation of new dashboard pages
- Creation of new KPI graphs
- Reporting
- Impact analysis functions
- Map editor
- Multi-language support

6. Port Integration Requirements

This comprehensive framework outlines the essential requirements for managing operations within a port logistics center, focusing on the import and export processes, transportation management, cargo and container handling, and system integration. It emphasizes the need for a robust and efficient system capable of handling the complexities of cargo and container management, from order registration through to transportation and inventory management. The requirements cater to various stakeholders, including cargo owners, transport drivers, and logistics center operators, ensuring seamless coordination and communication among all parties involved.

The system is designed to facilitate the registration and management of import/export orders by cargo owners, streamline the entry and management of transportation vehicles, and oversee the loading details of cargo vehicles. It also includes the capability to register abnormalities in imported cargo, manage container import/export orders, and handle requests for container transportation. Moreover, the system aims to integrate with the schedules of mother ships for better planning and coordination of container loading/unloading and transfer management.

Key components of the system include managing work history through mobile devices for real-time updates on container operations, performance management of container imports and exports, and warehouse cargo inventory management to align system records with actual inventory. Additionally, the system will link with the cargo owner's system for enhanced data sharing and coordination, manage customer transportation orders, establish dispatch plans for transportation vehicles, and ensure the accurate reporting of vehicle departure and arrival.

To support these operational needs, the system will also incorporate functionalities for screen registration, ensuring that the programs configured in the system are well-managed, and user permission management, which controls access rights to various system screens. This holistic approach ensures that the logistics center operates efficiently, with a focus on accuracy, security, and timely communication, thereby enhancing the overall supply chain and logistics operations within the port environment.

Requirement	Description	Importance (H,M,S)	Storage	Integration	Management	Functional
Import/export order management of cargo owner	A Cargo owner registers and manages orders to be brought in/out to the logistics center.	H				O
Import/export order management	A Cargo owner manages orders for bringing cargo into or out of the logistics center.	H				O
Transportation vehicle entry management	A transport driver registers for the arrival of a transport vehicle to bring in or take out cargo at the logistics center.	M				O
Cargo vehicle registration	It registers and manages the loading details of cargo on the entered transport vehicle.	M				O

Registration of abnormalities in imported cargo	It registers abnormal details of imported bonded cargo.	M				O
Container import/exit order management	It registers and manages the import order for containers to be received at the request of the cargo owner.	H				O
Container import/export transport request	If the cargo owner requests transportation of an import container to the logistics center, a request is made to the transportation company to transport the import container.	H				O
Registration of container take-out order	It registers a take-out order for containers brought into the logistics center.	H				O
Linkage of mother ship arrival and departure berth schedules for import and export	The scheduled arrival date, scheduled departure date, import deadline, and berth schedule of the mother ship for import and export are received and used as basic information for container work and transport vehicle dispatch.	M				O
Receive terminal public information	It receives inventory information of containers held at the terminal by container type and standard.	S				O
Container loading and unloading and transfer management	It registers the unloading details and unloading location of containers brought into the logistics center.	H				O
Work history management using mobile	Container loading and unloading transfer details are entered directly from the equipment that operates the container.	M			O	
Container import and export performance management	Check container inventory by terminal arrival deadline and expected return date.	M				O
Warehouse cargo inventory management	It registers inventory details of warehouse cargo and adjusts inventory in the system to actual inventory.	S				O
Linkage with shipper's system	It is linked to the cargo owner's computer system.	M			O	
Customer transportation order management	It registers and manages transportation orders requested by customers from transportation companies.	H				O
Establishment of dispatch plan	It establishes a distribution plan for transportation vehicles for customer transportation orders.	H				O
dispatch	It dispatches transport vehicles and drivers according to the dispatch plan.	M				O
Transport vehicle departure/arrival reporting	It dispatches transport vehicles and drivers according to the dispatch plan.	M				O
Screen registration	It registers and manages programs configured in the system.	M			O	

User permission management	It manages user access rights for each screen.	M			O	

6.1 Integration with Transportation Operation

In Port operation it is important to integrate various tasks such as dispatching management of carriers, handling transport orders, and settling sales by customer. In the integration operation of Port transportation, there are standardization and simplification of transportation work to support carriers to increase efficiency and productivity and customer satisfaction through the following operational works.

- unit registration and instruction document files,
- performance reporting document files,
- sales reporting document files,
- standardization and simplification of transportation order forms,
- registration and management of information by customer,
- registration and management of paid vehicles and vehicles by customer,
- automation of sales and settlement by customer,
- backup and Excel download of settlement data, and
- optimization for shuttle transportation can help carriers increase efficiency and productivity and customer satisfaction.

In order to support the operational works, the TMS (Transport Management System) is required to provide the following functions.

- order registration and management functions,
- dispatch registration and management functions,
- dispatch instruction and status,
- transportation instruction and status,
- freight calculation based on transport cancellation and round policy establishment,
- fare policy in the event of a round due to a mistake in dispatch or a change in shipping information to improve transportation inefficiency,
- standardization and simplification of transportation system,
- enhancement of efficiency, productivity, and customer satisfaction cater to various stakeholders, including cargo owners, transport drivers, and logistics center operators,
- ensuring seamless coordination and communication among all parties involved.

It emphasizes the need for a robust and efficient system capable of handling the complexities of cargo and container management, from order registration through to transportation and inventory management.

Requirement	Description	Importance (H,M,S)	Storage	Integration	Management	Functional
Transportation vehicle entry management	A transport driver registers for the arrival of a transport vehicle to bring in or take out cargo at the logistics center.	M				O
Registration of abnormalities in imported cargo	It registers abnormal details of imported bonded cargo.	M				O
Screen registration	It registers and manages programs configured in the system.	M			O	
User permission management	It manages user access rights for each screen.	M			O	
Simplifying transportation and transportation forms	Simplifying transportation tasks such as unit distribution registration and instruction work, performance reporting work, and sales reporting improves work efficiency.	M				O
Standardization and simplification of transportation order forms	Standardization of transportation order forms prevents unnecessary document work and enables more efficient business processing.	M				O
Ability to register and manage information by customer	Smooth communication and quick response with customers will be possible, and work efficiency will increase.	H				O
Function to register and manage paid vehicles/use vehicles by customer	You can manage vehicle operations more efficiently and respond quickly if necessary.	H				O
Automation function of sales performance and settlement by customer	You can check the sales performance accurately and quickly for each customer, and you can prevent errors or omissions in the settlement process.	H				O
Ability to back up settlement data and download Excel	Data can be downloaded as a backup and Excel file when settlement is completed, and it will also help you plan your future sales work.	H				O
a system optimized for shuttle transportation	Shuttle transportation dispatch plans and reservations can be systematically	M				O

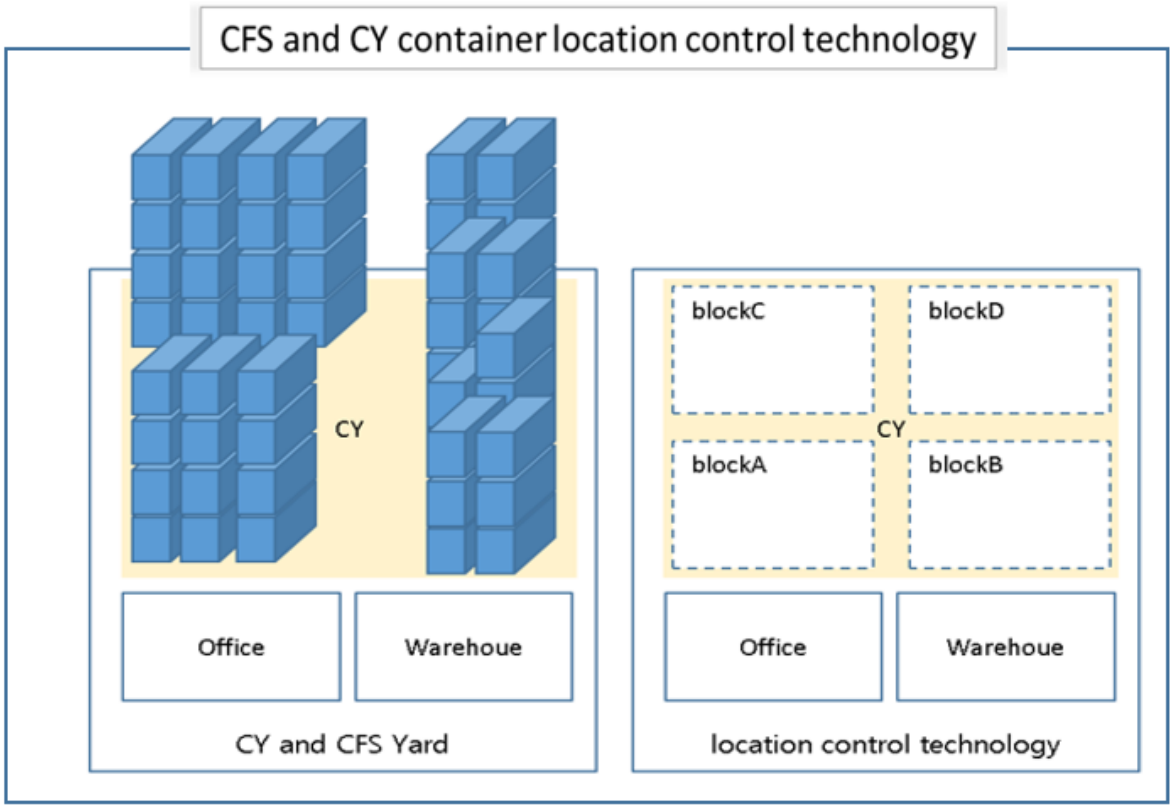
	managed by each carrier, and the convenience of carriers can be improved.					
Ability to register and manage orders	You can systematically manage the entire process from receiving and dispatching transport orders, and increase customer satisfaction and reliability.	M				O
Ability to register and manage dispatch	You can systematically manage the dispatch schedule of transport orders and efficiently operate the vehicle.	H				O
Dispatch instructions and status, transport instructions and status	You can monitor the dispatch and transport status of transport orders in real time and respond immediately when problems arise.	H				O
Calculation of freight charges according to cancellation of transportation and establishment of round policy	You can calculate appropriate freight charges and protect the company's profits in the event of shipping cancellation and rounds of shipping orders.	H				O
Standardization and simplification of transportation operations by revamping the inefficiency of transportation tasks, fragmented information	It can increase work efficiency and reduce costs for carriers.	M				O

6.2 Integration with Container Freight Station (CFS)

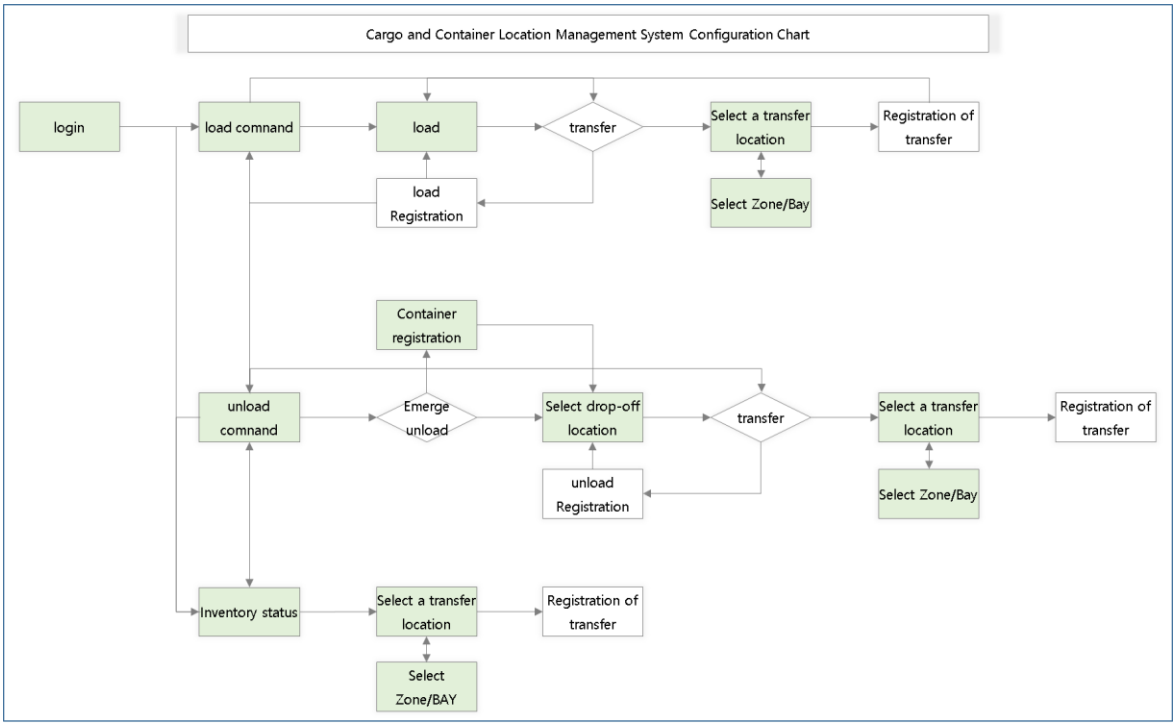
Type and quality of containers have been digitized to manage the method of recording the location information of cargo and containers by handwriting. On real-time reflection of pre-shipment and import/export information, the following information data are important to support a reduction in number of rounds due to failure to bring into the terminal.

- tracking the location of cargo and containers when taken out,
- cargo status,
- inventory identification,
- waiting LOSS,
- export deadline expiration.

This leads to the elimination of resource waste, increased throughput, and sales, thereby reducing congestion in the yard and maximizing the efficiency of yard operation.



This comprehensive framework outlines the essential requirements for managing operations within a port logistics center, focusing on the import and export processes, transportation management, cargo and container handling, and system integration.



Terminal operators can collect and effectively manage information from the container yard in real time to minimize congestion in the yard and maximize the efficiency of yard operations.

To achieve this, you can share and ensure reliability of container information and import/export information at the time of import/export to minimize congestion in the yard and maximize the efficiency of yard operations by sharing information data in real time.

Processing volume and sales decrease due to increased wasteful transfer operations such as loading cargo, difficulty in checking container status for extraction work, and lowering and raising cargo due to incorrect timing of shipment, Inefficient task of generating duplicate information on import and export cargo and delivering it to terminals and CFS operators frequently, Verifying real-time central control and monitoring, Productivity decline as a result of the wasteful work of gathering scattered fragmented information, such as shipping company information, cargo/container information/transport information, etc .

Frequent occurrence of LOSE waiting due to relief of transport dispatch and cargo transfer work plan, To compensate for problems such as frequent failure to bring in terminals and increase in number of times due to the expiration of container inventory, digitize cargo or container information to identify real-time inventory, eliminating waste of resources used to dispose of emergency cargo, Share and secure reliability of information on bringing in/exporting containers by inventory, We need a reliable information platform for import and export cargo, such as container workers and 'seal' sealing information, troubleshooting these problems and profitability will increase the efficiency of the night operation, and profitability will increase customer satisfaction and profitability.

The system is designed to facilitate the registration and management of import/export orders by cargo owners, streamline the entry and management of transportation vehicles, and oversee the loading details

of cargo vehicles. It also includes the capability to register abnormalities in imported cargo, manage container import/export orders, and handle requests for container transportation.

Key components of the system include managing work history through mobile devices for real-time updates on container operations, performance management of container imports and exports, and warehouse cargo inventory management to align system records with actual inventory.

Requirement	Description	Importance (H,M,S)	Storage	Integration	Management	Functional
Import/export order management of cargo owner	A Cargo owner registers and manages orders to be brought in/out to the logistics center.	H				O
Import/export order management	A Cargo owner manages orders for bringing cargo into or out of the logistics center.	H				O
Screen registration	It registers and manages programs configured in the system.	M			O	
User permission management	It manages user access rights for each screen.	M			O	
Sharing container information and securing reliability when carrying in and out	Container information including location, specifications, and carry-in and carry-in information is collected in real time and stored in the database to manage it. This can increase the accuracy and reliability of carry-in and carry-in information.	H				O
Share and secure reliability of incoming/exporting information	You can collect and share information data in real time to ensure transparency of information and increase the efficiency of yard operations.	M				O
Frequent LOSS due to frequent visits to the office to check the information on bringing in/out	Real-time support for bring-in/out information through mobile apps or websites; improves yard operations efficiency and reduces standby LOSS.	M				O
Difficulty in checking container status for loading and extraction work, which are cargo status information	Use mobile apps or websites to monitor the status of containers in real time and detect anomalies. You can take action in the right place to increase the efficiency of yard operations.	H				O

Reduced throughput and sales due to increased wasteful transfer operations such as unloading and lifting cargo due to mismatched timing of shipment	Real-time collection of incoming/export information and a yard operation plan based on this can be developed to increase the efficiency of yard operations by placing cargo in the right place and minimizing transfer operations.	M				O
Inefficient task of generating duplicate information on import and export cargo and delivering it to terminals and CFS operators frequently	Information on import and export cargo is managed in an integrated manner and shared with relevant parties in real time, which can increase the efficiency of yard operations and eliminate the inefficiency of operations.	M				O
Verifying real-time central control and monitoring	Monitor all situations in the yard in real time, take timely action, and increase the efficiency of yard operations.	M				O
Productivity decline as a result of wasteful collection of scattered fragmented information such as shipping company information, cargo information/container information/transport information	Information on import and export cargo can be managed in an integrated manner, and information data can be shared in real time to increase the efficiency of yard operations and eliminate work inefficiency.	H				O
Frequent occurrence of waiting LOSS due to incongruity of transportation dispatch and cargo transfer work plan	Real-time collection of incoming/export information and a yard operation plan based on this can be developed to increase the efficiency of yard operations by placing cargo in the right place and minimizing transfer operations.	M				O
Eliminating waste of resources used to handle emergency cargo	Prioritize emergency cargo and prioritize emergency cargo. Save resources for emergency cargo handling and increase the efficiency of yard operations.	M				O
Secure reliability of import and export cargo such as container workers, seal information, etc	Integrated management of information on import and export cargo and sharing real-time information data can increase yard	M				O

	operations efficiency and eliminate inefficiency.					
Share and secure reliability of import/export information by container inventory	By real-time understanding of container inventory, you can develop a yard operation plan, minimize congestion within the yard, and maximize the efficiency of yard operations.	H				O
Frequent failure to bring into the terminal and increase in number of times due to the expiration of the container inventory	The efficiency of yard operation can be maximized by real-time understanding of container inventory status, carry-in and take-out information, and real-time understanding of take-out deadlines and terminal information.	H				O
Digitize cargo or container information to identify real-time inventory by bringing it in and out	Monitor the information and status of the container in real time and collect the information on the import/export in real time.	H				O

6.3 Data Interface between Systems

Moreover, the system aims to integrate with the schedules of mother ships for better planning and coordination of container loading/unloading and transfer management. Additionally, the system will link with the cargo owner's system for enhanced data sharing and coordination, manage customer transportation orders, establish dispatch plans for transportation vehicles, and ensure the accurate reporting of vehicle departure and arrival.

It is necessary to collect information from the yard in real time and increase transportation efficiency through smart dispatch using the platform's cargo and container information. Smart dispatch requires a platform that can collect and manage the information brought in/out of the yard in real time. The platform should be able to manage a variety of information, including maritime transport information and trade information, as well as in-yard import/export information. Smart dispatch by utilizing the platform's cargo and container information can increase transportation efficiency.

In other words, we collect the information from the yard in real time, while effectively managing this, you can choose the most appropriate mode of transportation and route to proceed with the delivery. Therefore, we minimize the time loss by sharing the transportation scheduled information with the distribution center (CFS) in real time, It is necessary to control the flow of cargo transportation and terminal loading by sharing cargo loading information in real time, centering on the distribution center (CFS). During the freight and container information generation phase, platform participants can share reliable information data to minimize congestion in the yard, increase the efficiency of yard operations, and improve terminal operators' profitability.

We need a platform that can give trust to the Korea Customs Service and the authors of various customs information. To support these operational needs, the system will also incorporate functionalities for screen registration, ensuring that the programs configured in the system are well-managed, and user permission management, which controls access rights to various system screens.

It securely stores all transactions that occur within CFS by sharing technologies such as high-security blockchain in real-time with information on the import/export of cargo in the yard, It strengthens high security and reliability by implementing anomaly detection and automatic response functions using AI technology, and collects reliable shipping company information and container information data through cooperation with overseas shipping companies and terminals, We need a platform that can link this with domestic terminals to understand the exact packing list of cargo and the status of cargo handling

This holistic approach ensures that the logistics center operates efficiently, with a focus on accuracy, security, and timely communication, thereby enhancing the overall supply chain and logistics operations within the port environment.

Requirement	Description	Importance (H,M,S)	Storage	Integration	Management	Functional
Container import/export transport request	If the cargo owner requests transportation of an import container to the logistics center, a request is made to the transportation company to transport the import container.	H				O
Linkage of mother ship arrival and departure berth schedules for import and export	The scheduled arrival date, scheduled departure date, import deadline, and berth schedule of the mother ship for import and export are received and used as basic information for container work and transport vehicle dispatch.	M				O
Receive terminal public information	It receives inventory information of containers held at the terminal by container type and standard.	S				O
Linkage with shipper's system	It is linked to the cargo owner's computer system.	M			O	
User permission management	It manages user access rights for each screen.	M			O	

Monitor terminal congestion and congestion	By collecting and effectively managing in-yard information in real time, you can minimize congestion in-yard and maximize the efficiency of yard operations.	H				O
Monitor terminal fit capability and operational efficiency	By collecting and effectively managing in-yard bring-in/out information in real time, you can minimize congestion in-yard and maximize the efficiency of yard operations.	H				O
Consistent, reliable cargo information platform	A consistent and reliable cargo information platform is required to collect and effectively manage the information brought in and out of the yard in real time. This platform can provide various functions such as sharing and securing reliability of information brought in and out, and predicting when to bring in and out.	H				O
Securing the sharing system of terminal operation plan information	In order to collect and effectively manage the information brought in and out of the yard in real time, a system for sharing terminal operational planning information is required, which can systematically manage the entire process from yard operational planning to execution and increase the efficiency of yard operations.	H				O
Securing the overall cargo movement flow based on priority reflecting the dock berth information of the ship	In order to collect and effectively manage the carrying/carrying information in the yard in real time, it is necessary to ensure that the overall cargo flow is based on priority, reflecting the dock berth information of the ship. This minimizes congestion in	M				O

	the yard and maximizes the efficiency of yard operations.					
Data sharing through a platform capable of converging cargo and shipping data	Data sharing through a platform capable of converging cargo and shipping data is required to collect and effectively manage the information brought in and out of the yard in real time. This platform allows you to manage a variety of information, including maritime transportation and trade information, in addition to the information brought in and out of the yard.	H				O
Improve transportation efficiency through smart dispatch using platform cargo and container information	In order to collect and effectively manage information from the yard in real time, it is necessary to increase transportation efficiency through smart dispatch using the platform's cargo and container information. This minimizes congestion in the yard and maximizes the efficiency of yard operations.	H				O
Minimize time loss by real-time sharing of transportation scheduled information with distribution center (CFS)	In order to collect and effectively manage in-yard carry-in/out information in real time, it is necessary to minimize time loss by sharing scheduled transport information with the distribution center (CFS). This minimizes congestion in-yard and maximizes the efficiency of yard operations.	M				O
Development of a data platform that platform participants can trust during the cargo and container information generation stage	Real-time collection and effective management of yard-to-yard information requires the development of a data platform that platform participants can trust during the cargo and container	H				O

	information generation phase. This can minimize congestion in the yard and maximize the efficiency of yard operations.					
Controlling the flow of cargo transportation and terminal loading by sharing the cargo loading information in front and rear in real time centered on the distribution center (CFS)	In order to collect and effectively manage the incoming/exporting information in the yard in real time, it is necessary to share the forward and backward cargo loading information around the distribution center (CFS) in real time to control the flow of cargo transport and terminal loading. This minimizes congestion in the yard and maximizes the efficiency of yard operations.	H				O
Reliability Platform for Customs Service and Various Customs Information Generators	In order to collect and effectively manage the information brought in and out of the yard in real time, we need a platform that can give credibility to the Customs Service's various customs information generators. This can minimize congestion in the yard and maximize the efficiency of yard operations.	M		O		
Securing security and reliability through the development of CFS control system technology incorporating blockchain and AI technology	Blockchain technology applies real-time blockchain technology to safely store all transactions occurring in CFS, and AI technology is used to enhance security and reliability by implementing anomaly detection and automatic response functions	H		O		O
Identify the exact packing list of cargo and the status of cargo handling by linking foreign terminals with reliable shipping company information	It collects reliable shipping company information and container information data through cooperation with overseas terminals and links them with domestic terminals to understand the exact	H		O		

and container information data	packing list of cargo and the status of cargo handling					

6.4 Port Operational Service

Automated Container Handling System (ACHS) is an essential technology for efficient port operations. By effectively coordinating container movements through centralized scheduling and management, considering factors like import/export requests, transportation system data, and port logistics center information, the productivity and efficiency of port operations can be significantly improved. Moreover, by monitoring the overall port terminal situation in real-time, it enables dynamic responses to continuously changing environments, thereby improving the safety and reliability of port operation systems.

- Intelligent Container Yard Management

The port logistics center serves as an intermediary connecting the port terminal and customers, and it's crucial to handle container import and export requests efficiently. By strategically positioning containers based on import/export container request plans, the system aims to process containers as quickly as possible. To achieve this, real-time data integration with both port terminal and transportation systems is required to compute the expected arrival times of vehicles. Moreover, container processing durations are predicted according to the locations of containers, and container positions are adjusted correspondingly in response to vehicle arrival times. This enables efficient logistics distribution at the port logistics center, minimizing delays

- Inter-Terminal Logistics Flow Management

The current status of each terminal within the port logistics center is assessed based on container loading information and scheduled request plans. Considering the processing capacity of the port logistics center, the operational status of each terminal is assessed. Based on this evaluation, container requests are allocated to the appropriate terminals. Utilizing data integration with port terminals and customers, container request plans are gathered, and container allocation is determined according to the status of the port logistics center to optimize processing speed. Also, real-time monitoring allows for flexible allocation changes in response to environmental changes, which enhances port logistics system safety and reliability

6.5. Port Prediction Requirements

The port logistics system operates in a complex manner with involvement from various stakeholders such as shippers, transportation companies, and warehouse operators. Therefore, to enhance the operational efficiency of port logistics, it is imperative to dynamically plan logistics flows by comprehensively considering data provided by stakeholders. In order to formulate appropriate logistics plans, the following predictions are necessary.

- Terminal Trade Volume Prediction

The starting and ending point of the logistics workflow within a port is mainly the port terminal and inland terminal. In order to be able to establish a logistics plan that optimizes logistics workflow, it is necessary to be able to predict trade volume, including the volume of cargo unloaded from ships/vehicles to terminals and the volume of cargo loaded from terminals to ships/vehicles.

- Container Yard Inbound/Outbound Volume Prediction

Before cargo is transported from terminals to the inland or from inland to external destinations, containers are stored at container yards in facilities such as port logistics center. If containers are arbitrarily loaded at the yard without considering the volume of containers in and out, It can lead to increased retrieval times during outbound processes, thus reducing operational efficiency.

- Container Transport Time Model

To minimize delays due to bottlenecks in the port logistics process, it's crucial to consider transportation times along various routes when transporting containers. This requires the ability to infer the time taken for cargo to be transported to its destination via specific routes based on the current logistics flow situation

- Container Retrieval Time Model

The time required to retrieve containers can vary according to the current loading layout in container yard. Since containers are typically stacked in multiple tiers in container yard, improper loading plans may result in the container intended for retrieval being positioned at the bottom, causing unnecessary additional work. To establish proper loading plans for container yard, it's important to appropriately consider the time required for retrieval based on specific positions and tiers within the yard.

6.6 Port Scenario Specific Platform Requirements

This section provides the specific platform requirements to support Data Trust, Blockchain and Digital Twin functionalities in the Port Application.

- Blockchain capability

Highly reliable logistics service solutions based on blockchain technology can create a differentiated logistics platform. In order to disclose cargo and customer information, as well as cargo or container location and loading information to various logistics market participants and provide intelligent services based on them, a highly reliable platform is the foundation. To link information, it is essential to ensure trust in multilateral information security and the ability to modify information, so blockchain is an essential technology implementation. By maintaining data confidentiality through multilateral computation and using blockchain, it is possible to achieve data centralization in a wide range, including CFS front and back services based on high trust.

- Digital Twin

In order to provide digital twin-based services, the digital twin platform for optimal transportation of containers between Container Freight Station and Pusan Container Yard in New Pusan Port must support the renewal and operation of the digital twin and interface with other programs. The properties and behavior of the digital twin are updated by processing collected data, such as real-time container and yard information. The schedule created through the user interface or optimization algorithm is input into the digital twin and simulated. The derived optimization index and other matters of interest are stored in the database so that they can be displayed to users.

- Data Trust

Data trust provisioning and data quality management are essential technologies for Port platform including operation services. Inaccurate or anomalous data can lead to erroneous outcomes, which can significantly impact the entire port logistics system. To mitigate this, the reliability and trustworthiness of collected data are evaluated based on historical data, and overall data quality management is conducted across the main database. By guaranteeing the reliability of data pertaining to container information and the status within port logistics centers, it ensures seamless operation of subsequent port operation services.