Secure Open Collaboration Framework powered by Artificial Intelligence

30 Dec 2023

Abstract

Detailed literature reviews for SOCFAI topics

Contents

Introduction

The document is a comprehensive literature review focusing on the Secure Open Collaboration Framework powered by Artificial Intelligence (SOCFAI), with a publishing date of December 30, 2023. The review covers a wide range of topics essential to the logistics and aviation industries, emphasizing the integration of AI and big data analytics to enhance operations. Key areas include addressing skills shortages and infrastructure optimization in logistics, collaborative business models, dynamic solutions for Ground Handling Systems (GHS) and Resource Management Systems (RMS), and the management of data variety, velocity, and volume on SOCFAI platforms.

In-depth discussions are presented on the implementation of AI in operation control frameworks, highlighting the influence on firm performance and risk management. The review also delves into real-time analytics and the application of multimodal deep learning and sentiment analysis using social media datasets. Additionally, it explores innovative technologies like LiDAR for passenger flow tracking and presents an extensive review of data analytics in luggage control systems.

The latter sections focus on the energy flow at airports, detailing technical foundations and mechanisms to reduce energy consumption, with particular emphasis on HVAC systems, energy grid import, and bridge control. The review provides an insightful overview of current trends, challenges, and technological advancements shaping the future of logistics, aviation, and energy management in airport environments.

1 . Logistics Skill Shortages in the European Union & 1a. Logistics Property and Infrastructure Optimization

The logistics industry in the European Union (EU) is indeed facing challenges related to skills shortages and infrastructure optimization. The shortage of logistics personnel in the EU has been noted, and the reliability and performance of logistics have been declining in recent years (Gnap et al., 2020). This shortage is not unique to the EU, as there is a general scarcity of educated and skilled logistics and supply chain managers worldwide (Cronjé, 2015). Furthermore, the EU is also experiencing critical healthcare workforce shortages, primarily related to demographic changes such as growing and aging populations with multi-morbidity and polypharmacy (Solum et al., 2020). These shortages have been attributed to various factors, including demographic changes and the evolving regulatory framework (Musazzi et al., 2020).

In addition to skills shortages, the optimization of logistics property and infrastructure is crucial. The development of logistics infrastructure in the EU and its competitive advantages has been investigated, highlighting the importance of this aspect (Шкуренко & Savchenko, 2019). Furthermore, the impact of transport and logistics on trade facilitation has been studied, emphasizing the significance of efficient logistics infrastructure for trade (Sénquiz-Díaz, 2021). The integration problems of the Union transport area elements, including customs and logistics infrastructure, have also been examined, indicating the complexity of logistics infrastructure development within economic unions (Malevich et al., 2020).

Here is the 4 points of logistic skill shortages;

- Global Perspectives on Skills Shortages: Research indicates that the shortage of skilled logistics personnel is a global challenge. Recognizing the global nature of the issue is crucial when considering the implementation of a big data platform at airports, as the success of such a platform often depends on skilled personnel for its design, implementation, and maintenance.
- Technological Competence and Big Data: Best practices in addressing skill shortages involve investing in education and training programs that specifically target technological competencies, including big data analytics. Ensuring that the workforce possesses the necessary skills to leverage data for logistics optimization is vital for the successful implementation of big data platforms at airports.
- Collaboration with Educational Institutions: Establishing partnerships between the aviation industry and educational institutions can facilitate the development of tailored programs to address skill shortages. This collaboration can focus on creating curricula that integrate big data analytics, artificial intelligence, and other relevant technologies into logistics and supply chain management courses.
- Continuous Learning and Adaptation: The dynamic nature of the logistics industry requires a commitment to continuous learning. Encouraging employees to engage in ongoing training programs and certifications related to big data analytics ensures that the workforce remains adaptable and well-equipped to handle the evolving challenges in logistics.

The optimization of logistics property and infrastructure is essential for trade facilitation and economic development. The impact of high-quality logistics services on trade facilitation has been highlighted, emphasizing the role of logistics in enabling and enhancing trade (Korinek & Sourdin, 2011). Moreover, the formation of effective logistic infrastructure for enterprises has been studied, indicating the importance of infrastructure optimization for specific industries such as bottled water manufacturing (Chernova et al., 2015).

Here is the 4 points of logistic property and infrastructure optimization;

- Strategic Planning for Infrastructure Development: Best practices in logistics infrastructure optimization involve strategic planning that aligns with the overall goals of the aviation industry. For the implementation of a big data platform at airports, infrastructure development should consider the data storage, processing, and connectivity requirements, ensuring seamless integration with existing systems.
- Technological Integration: Integrating advanced technologies into logistics infrastructure is essential. For big data platforms at airports, this means incorporating technologies such as Internet of Things (IoT) sensors, RFID tracking, and automated data collection systems. The integration of these technologies enhances the efficiency of data gathering and processing.
- Public-Private Partnerships: Successful infrastructure optimization often involves collaboration between public and private entities. Public-private partnerships can provide the necessary resources and expertise for implementing big data platforms at airports. Such collaborations contribute to the development of well-connected and technologically advanced logistics networks.

- Performance Monitoring and Data Analytics: Implementing performance monitoring systems and utilizing data analytics are crucial for optimizing logistics property. For airports, this includes real-time monitoring of cargo movements, passenger flows, and other critical data points. Big data analytics can uncover patterns and trends, enabling informed decision-making for infrastructure improvements (Korinek & Sourdin, 2011).

Overall, the logistics industry in the EU faces challenges related to skills shortages and infrastructure optimization. Addressing these challenges is crucial for maintaining efficient logistics operations, facilitating trade, and supporting economic growth within the EU.

The following 4 points is how these topics related to the big data platforms at airports.

- Data Governance and Security: The implementation of big data platforms at airports necessitates robust data governance and security measures. Best practices involve establishing clear data ownership, access controls, and encryption protocols to ensure the integrity and confidentiality of sensitive information.
- Interconnected Systems for Seamless Operations: A key consideration for airports implementing big data platforms is the integration of systems for seamless operations. This includes connecting the big data platform with existing airport management systems, air traffic control, and logistics networks to achieve a unified and comprehensive approach to data utilization.
- Predictive Analytics for Resource Optimization: Leveraging big data analytics for predictive modeling can enhance resource optimization at airports. This involves predicting passenger volumes, optimizing cargo handling processes, and anticipating maintenance needs based on historical data, contributing to more efficient logistics operations.

To sum up, addressing skill shortages and optimizing logistics property and infrastructure are integral components of successfully implementing a big data platform at airports. By incorporating best practices from the literature research, the aviation industry can build a workforce with the necessary skills and create a technologically advanced infrastructure that supports the seamless integration of big data for enhanced efficiency and decision-making.

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2 . Collaborative Business Models in the Transportation and Logistics Industry & Integration of Networks and Actors in Global Ports, Airports

Collaborative business models in the transportation and logistics industry are crucial for enhancing service performance and achieving sustainable marketing in a B2B context (Stank et al., 2001). The integration of networks and actors in global ports and airports is essential for stimulating growth based on logistics and for providing efficient and reliable services to global production networks (Lavissière et al., 2019; Raimbault et al., 2015). The application of a relational perspective to port regionalization allows for the analysis of how various actors engage strategically in actor-networks and coalitions across scales to stimulate growth based on logistics (Raimbault et al., 2015). Furthermore, the integration and unification of the overall value, information sharing, and collaborative operation between upstream and downstream partners of the supply chain are crucial for forming a good business operation network environment (Geng et al., 2022). Additionally, the emergence of fine art logistics studies was primarily driven by the need for collaborative-innovative spaces to enhance the activities of the creative industry (Legino et al., 2021).

Best Practices and Solutions fo Colloborative Business Models in the Transportation and Logistic Industry:

- Data Sharing Platforms: Collaborative business models thrive on effective data sharing. Implementing centralized data-sharing platforms facilitates real-time information exchange among different entities within the airport ecosystem. This enables better decision-making and streamlines operations.
- Open APIs and Standards: Adoption of open Application Programming Interfaces (APIs) and industry standards ensures interoperability between different systems. This allows various stakeholders to connect their systems seamlessly, promoting collaboration and reducing integration challenges.
- Predictive Analytics: Leveraging big data analytics for predictive insights can enhance collaboration. By analyzing historical data, airports can forecast demand, optimize resource allocation, and improve overall efficiency in the supply chain.
- Blockchain for Trust and Transparency: Blockchain technology can be employed to establish trust and transparency in collaborative models. Smart contracts and decentralized ledgers ensure that all stakeholders have access to the same, tamper-proof information, reducing disputes and improving cooperation.

- Real-time Communication Platforms: Implementing real-time communication tools facilitates instant information exchange. This is particularly critical during unforeseen events or disruptions, allowing stakeholders to quickly adapt and coordinate responses.

Best Practices and Solutions for Integration of Networks and Actors in Global Ports and Airports:

- Unified Data Architecture: Establishing a unified data architecture is essential for integrating diverse networks. This involves creating a centralized data repository that can aggregate and analyze data from various sources, providing a comprehensive view of operations.
- IoT Sensors for Real-time Monitoring: Integration is bolstered by real-time data. Deploying Internet of Things (IoT) sensors across airports enables continuous monitoring of various parameters, from baggage handling to aircraft movements, ensuring a constant flow of data for decision-making.
- AI-driven Decision Support Systems: Artificial Intelligence (AI) systems can analyze vast amounts of data to provide actionable insights. Implementing AI-driven decision support systems aids in optimizing processes, predicting bottlenecks, and enhancing overall operational efficiency.
- Interoperable Technologies: Ensuring that different technologies used by various actors in the airport ecosystem are interoperable is crucial. This can be achieved through standardization and the adoption of common protocols, facilitating smoother data exchange.
- Cybersecurity Measures: With increased integration comes a heightened risk of cyber threats. Robust cybersecurity measures are essential to protect sensitive data and ensure the smooth functioning of integrated networks.

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3 . Dynamic GHS and RMS Solutions

The integration of dynamic Ground Handling System (GHS) and Resource Management System (RMS) solutions is crucial for optimizing operational efficiency and resource allocation in the aviation industry. The adoption of new solutions based on the GH-MF system supports a method involving dynamic Re-OPF, which is essential for addressing multi-objective optimization problems in architectural design exploration (Ding et al., 2020). Furthermore, the study of inverse kinematics is critical for the design, trajectory planning, and control of redundant manipulators, and the complexity of solving IK problems with innumerable solutions can be addressed through novel algorithms that combine nonlinear workspace partition with neural networks (Dong et al., 2021). Additionally, the explanation of the locking of a four-node plane element by considering it as an elastic Dirichlet-type boundary value problem provides insights into the conservation laws of momentum, which are fundamental for understanding the behavior of dynamic systems such as GHS and RMS (Molenkamp et al., 2000).

Traditional GHS face challenges in adapting to dynamic operational conditions at airports. Delays, fluctuating passenger volumes, and changing aircraft schedules demand a more flexible and responsive system.

Best Practices:

- Real-time Data Integration: Dynamic GHS should integrate real-time data from various sources, including weather conditions, flight schedules, and passenger information. This integration enables proactive decision-making and resource allocation.
- Predictive Analytics: Implementing predictive analytics allows airports to anticipate operational disruptions and optimize ground handling processes accordingly. Machine learning algorithms can analyze historical data to predict potential delays or resource requirements.
- Automated Resource Allocation: Dynamic GHS should incorporate automated resource allocation algorithms. This ensures optimal utilization of ground handling resources, reducing idle time and improving overall efficiency.

RMS traditionally faces challenges in adapting to the dynamic nature of airport operations. Manual resource allocation processes may lead to inefficiencies and increased operational costs.

Best Practices:

- Integrated Information Architecture: Implementing an integrated information architecture that connects RMS with other airport systems (such as GHS, passenger information systems, and security systems) provides a holistic view of airport operations. This integration enables better decision-making and resource optimization.
- Dynamic Resource Allocation: RMS should employ dynamic resource allocation mechanisms that can adjust in real-time based on changing conditions. This ensures that resources are allocated efficiently, taking into account current operational demands.
- Cloud-Based Solutions: Leveraging cloud-based RMS solutions facilitates scalability and flexibility. Cloud platforms can handle large volumes of data generated by airport operations, enabling efficient data processing and storage.

Integrating dynamic GHS and RMS solutions with big data platforms enhances their capabilities. Big data analytics can provide valuable insights, optimize operations, and contribute to overall airport efficiency.

Best Practices:

- Real-time Monitoring and Analytics: Utilizing big data analytics for real-time monitoring of airport operations allows for proactive decision-making. Predictive analytics can identify patterns and potential issues, enabling airports to take corrective actions before problems escalate.
- Data Security and Privacy: Implementing robust security measures is crucial when dealing with sensitive operational data. Big data platforms should adhere to industry standards and regulations to ensure data security and privacy.
- Scalable Infrastructure: Building a scalable infrastructure on big data platforms enables airports to handle the increasing volume of data generated by various systems. This scalability ensures that the airport's data infrastructure can evolve with growing operational needs.

To conclude, Dynamic GHS and RMS solutions, integrated with big data platforms, represent a significant step forward in optimizing airport operations. By adopting best practices such as real-time data integration, predictive analytics, and cloud-based solutions, airports can enhance their efficiency, reduce costs, and provide a seamless experience for passengers. The successful implementation of these solutions requires a comprehensive approach that considers the integration of various systems and adherence to data security standards.

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4 . Airport, Port Operations Management and IT Systems

The integration of IT systems in airport and port operations management is crucial for enhancing efficiency, sustainability, and competitiveness in the global logistics and transportation industry. Digitalization and the adoption of technologies such as Building Information Modeling (BIM) and smart airport life cycle management frameworks have been identified as enablers for digital transformation in mega projects and smart airports (Koseoglu et al., 2019; Keskin & Salman, 2020). Furthermore, the digitalization of maritime logistics, including the implementation of Just-In-Time approaches and port community systems, has been recognized as a sustainable solution for improving operational processes and interoperability in port operations (Gonzalez et al., 2021; Seo et al., 2022). The application of Information & Communication Technology (ICT) in port terminal operations has been highlighted as essential, particularly in developing economies, to address challenges associated with manual operations and improve overall efficiency (Onwuegbuchunam et al., 2021).

In addition to digital transformation, the governance and management of ports and airports have been subjects of extensive research. Studies have emphasized the need for effective port governance, considering the impact of broader policies, institutional layering, and the role of port authorities in the ever-changing operational environment (Verhoeven, 2010; Notteboom & Yang, 2017; Zhang et al., 2019). Furthermore, the multi-stakeholder perspective in evaluating port performance and the determinants of passenger loyalty in multi-airport regions have been explored to converge different objectives and concerns for better management and to analyze passenger perceptions and attitudes regarding the airport experience (Ha et al., 2019; Bezerra & Gomes, 2019).

Moreover, the role of port operations in contributing to sustainable development goals has been a focus, with efforts directed towards developing and deploying port sustainability management systems to assess the potential impact of operations on sustainability (Katuwawala & Bandara, 2022). Additionally, the impacts of transportation systems on military logistics support and the environmental licensing as an instrument for environmental management of public ports have been subjects of research, highlighting the broader implications of transportation and port operations beyond commercial aspects (Halizahari et al., 2022; Braga & Gomes, 2020).

The integration of Big Data in transportation management has gained prominence due to its potential in enhancing decision-making processes. In the context of airport and port operations, Big Data analytics can provide real-time insights, optimize resource allocation, and improve overall operational efficiency.

Understanding the challenges specific to airport and port operations is crucial for the successful implementation of Big Data platforms. Challenges may include complex logistics, security concerns, and the need for real-time data processing. Addressing these challenges is essential for the effective deployment of Big Data solutions.

Best Practices in Implementing Big Data Platforms:

- Data Integration: Efficient integration of diverse data sources, including passenger information, cargo details, weather conditions, and security data, is vital. Big Data platforms should seamlessly consolidate and analyze this information to derive meaningful insights.

- Real-time Analytics: Real-time analytics enable quick decision-making. Implementing technologies that process and analyze data in real-time helps enhance situational awareness, allowing airports and ports to respond promptly to changing conditions.
- Scalability and Flexibility: Big Data platforms must be scalable to handle the increasing volume of data in dynamic airport and port environments. Flexibility in adapting to evolving operational requirements ensures the longevity and relevance of the implemented solutions.
- Security and Compliance: Given the sensitivity of airport and port operations, security and compliance with industry regulations are paramount. Big Data platforms should adhere to robust security measures to protect sensitive information and ensure compliance with relevant standards.

Examining successful implementations of Big Data platforms in airports and ports provides valuable insights. Case studies highlighting notable achievements, such as improvements in operational efficiency, reduced delays, and enhanced security measures, offer practical guidance for other facilities.

Integration with the Internet of Things (IoT) and other emerging technologies, such as Artificial Intelligence (AI), can further enhance the capabilities of Big Data platforms. The synergy of these technologies can lead to more comprehensive and predictive insights.

Overall, the research on airport and port operations management and IT systems underscores the significance of digital transformation, governance, sustainability, and broader societal impacts in shaping the future of global transportation and logistics.

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5 . Data Variety, Velocity, and Volume Management in SOCFAI Platform

The effective management of data variety, velocity, and volume in big data platforms for airports is crucial for ensuring efficient and effective operations. The characteristics of big data, including volume, variety, and velocity, are essential considerations in the development and governance of big data platforms (Zhang & Xu, 2020; Miltiadou et al., 2021). The need for secure experimentation sandboxes and the inadequacy of traditional security and privacy mechanisms in coping with the rapid data explosion in complex distributed computing environments underscore the significance of addressing the 3V characteristics of big data (Miltiadou et al., 2021). Additionally, the evaluation of big data platforms through benchmarks can assess their capabilities with respect to the V characteristics, including volume, velocity, and variety (Kavakli et al., 2019). Furthermore, the construction of large data management platforms in various domains, such as healthcare and vocational education, highlights the importance of analyzing and summarizing the demand for big data applications, including the management of data volume, variety, and velocity (Wang & Wang, 2018; Zhou et al., 2018).

The references provide insights into the importance of addressing the 3V characteristics of big data, particularly in the context of developing and governing big data platforms for various domains. The considerations of volume, variety, and velocity are crucial for ensuring the effective integration and governance of multisource heterogeneous data in large hospitals and for addressing the challenges associated with large-scale cloud infrastructures and the Internet of Things (IoT) in the aviation domain (Wang et al., 2022; Miltiadou et al., 2021). Moreover, the application of benchmarks and the analysis of demand for big data applications emphasize the need to evaluate and address the characteristics of big data, including data variety, velocity, and volume, in the development and management of big data platforms (Kavakli et al., 2019; Wang & Wang, 2018).

Data Variety: Airports generate diverse data types, including passenger information, flight schedules, baggage tracking, weather data, security footage, and more. Managing this variety requires a flexible and scalable data architecture. Best practices involve implementing a robust data integration framework that can seamlessly handle structured and unstructured data. Utilizing technologies such as Apache Kafka for real-time data streaming and Apache Nifi for data routing and transformation can aid in efficiently managing data variety.

Data Velocity: Real-time data processing is essential for airports to make informed decisions promptly. Utilizing stream processing frameworks like Apache Flink or Apache Spark Streaming can help manage the high velocity of incoming data. Implementing event-driven architectures allows airports to respond swiftly to changes, such as flight delays or security incidents. Additionally, incorporating edge computing at airports can reduce latency, enabling faster processing of data at the source.

Data Volume: Airports deal with massive volumes of data, and efficient storage solutions are paramount. Cloud-based storage services, like Amazon S3 or Google Cloud Storage, offer scalability and cost-effectiveness. Implementing a data lake architecture allows airports to store and analyze large datasets efficiently. To optimize query performance, using distributed processing frameworks such as Apache Hadoop or Apache Spark on cloud infrastructure is recommended.

Integrated Solutions: Integrating data variety, velocity, and volume management solutions is crucial for a comprehensive big data platform at airports. Implementing a data governance framework ensures data quality, security, and compliance. Advanced analytics and machine learning models can be employed to extract actionable insights from the integrated data, improving airport operations, resource allocation, and predictive maintenance.

Security and Privacy: Given the sensitivity of airport data, security and privacy considerations are paramount. Implementing encryption, access controls, and regular audits can safeguard data integrity. Complying with industry regulations such as GDPR or HIPAA ensures the responsible handling of passenger and operational data.

In conclusion, effective management of data variety, velocity, and volume is imperative for successful big data platforms in airport environments. By incorporating the aforementioned best practices, airports can enhance operational efficiency, improve passenger experiences, and ensure the overall safety and security of their operations.

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6 . Multi-KPI Optimization for Task and Resource Allocation in Airports

The optimization of task and resource allocation in airports is a critical area of research, particularly in the context of multi-KPI optimization. Multi-KPI optimization involves configuring optimization algorithms with different key performance indicator (KPI) combinations and running them repeatedly to achieve the best allocation of resources for various tasks.

Chen et al. (2015) discuss the application of multi-objective optimization allocation to minimize the cost and time of delay, as well as fair loss deviation factor of airline companies in the multi-airport terminal area. This highlights the relevance of multi-objective optimization in addressing the complex challenges associated with airport operations, where multiple key objectives need to be considered simultaneously (Chen et al., 2015).

Furthermore, the study by Goddu & Reddi (2019) on task scheduling optimization in cloud computing environments using multi-objective optimization is relevant as it emphasizes the importance of optimized task scheduling based on particle swarm optimization for resource allocation. While the context is different, the principles of multi-objective optimization and resource allocation are transferable to the airport environment (Goddu & Reddi, 2019).

Additionally, the work by Alodhaibi et al. (2020) presents a framework for sharing staff between outbound and inbound airport processes, which involves resource allocation performed by an Advanced Resource Management (ARM) algorithm. This framework provides insights into the allocation of human resources in airport operations, which is an integral part of overall resource allocation in airport environments (Alodhaibi et al., 2020).

In summary, the research on multi-KPI optimization for task and resource allocation in airports can benefit from insights on multi-objective optimization, task scheduling, and resource allocation from related fields such as cloud computing and airport staff management.

Efficient airport operations demand a delicate balance between multiple key performance indicators (KPIs) such as passenger satisfaction, on-time performance, resource utilization, and safety. Traditional methods often fall short in achieving this balance due to the inherent complexity and dynamic nature of airport environments.

Big data platforms play a pivotal role in addressing the challenges of multi-KPI optimization at airports. These platforms enable the collection, processing, and analysis of vast amounts of data from various sources such as sensors, surveillance systems, and operational databases.

A critical aspect of big data platforms is their ability to facilitate data-driven decision-making. By harnessing real-time data, airports can optimize resource allocation based on current demand, weather conditions, and unforeseen events, leading to improved operational efficiency.

Predictive analytics, powered by big data, allows airports to anticipate operational bottlenecks and allocate resources preemptively. Machine learning algorithms can analyze historical data to predict peak periods, enabling proactive adjustments to staffing, security, and other critical resources.

Successful multi-KPI optimization requires integrated models that consider the interdependencies between tasks and resources. Advanced optimization algorithms, when coupled with big data analytics, can provide real-time solutions for task assignment, baggage handling, and gate allocation.

Big data platforms facilitate real-time monitoring of airport operations, enabling immediate feedback on KPIs. This feedback loop allows for continuous adjustments in resource allocation strategies, ensuring that the airport adapts to dynamic conditions efficiently.

Several airports worldwide have successfully implemented big data platforms for multi-KPI optimization. For instance, Singapore Changi Airport utilizes a comprehensive big data analytics platform to optimize passenger flow, baggage handling, and aircraft turnaround times, resulting in enhanced overall performance.

Implementing big data platforms in airports necessitates careful consideration of security and privacy concerns. Ensuring data integrity, protecting sensitive information, and complying with regulations are essential aspects of a successful big data implementation.

In conclusion, the integration of big data platforms in airports for multi-KPI optimization in task and resource allocation represents a cutting-edge approach to enhancing operational efficiency. By adopting data-driven decision-making, predictive analytics, and integrated models, airports can significantly improve passenger experience, safety, and overall performance.

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7 . AI-Powered Operation Control Framework

The development and implementation of an AI-powered operation control framework have significant implications for firm performance, risk management, and business processes. Mishra et al. (2022) demonstrate the mechanism through which AI influences firms' operating efficiency, highlighting the potential impact on profitability (Mishra et al., 2022). Additionally, (2021) examine frameworks for AI risk management, providing guidelines for required business processes to be implemented in order to address risks associated with intelligent decision making (Barta & Görcsi, 2021). Furthermore, Kumari et al. (2022) present a framework for now-casting and forecasting in augmented asset management, emphasizing the potential of AI as a powerful tool to solve problems related to operation and maintenance in industries (Kumari et al., 2022).

The research on hardware-based AI processors, as discussed by (Yoon et al., 2020), is also relevant as it leads to the minimization of AI devices, which is crucial for the practical implementation of AI-powered operation control frameworks (Yoon et al., 2020). Moreover, Xu et al. (2019) provide insights into platform-based business models in the context of an emerging AI-enabled smart building ecosystem, shedding light on the traditional approaches in the development of AI applications and their implications (Xu et al., 2019). Additionally, Sidorova & Rafiee (2019) illustrate a conceptual framework for mitigating AI agency risks through business process management, providing valuable insights through AI use cases and industry examples (Sidorova & Rafiee, 2019).

Therefore, the development of an AI-powered operation control framework involves considerations related to firm performance, risk management, hardware-based AI processors, platform-based business models, and AI agency risks. These aspects collectively contribute to the understanding and implementation of AI in the context of operational control frameworks.

AI-Powered operation control framework has 6 points in details such as:

- Data Collection and Integration: To build an effective AI-Powered OCF, the initial step involves the collection and integration of diverse data sources. This includes real-time data from flight schedules, baggage handling systems, security checkpoints, and passenger flow information. Best practices involve utilizing IoT devices and sensors strategically placed throughout the airport to capture relevant data.
- Machine Learning Algorithms: Implementing machine learning algorithms is essential for extracting meaningful insights from the collected data. Supervised learning algorithms can be employed for predictive analytics, allowing the airport to anticipate potential issues such as flight delays, baggage mishandling, or security concerns. Unsupervised learning algorithms can be utilized for anomaly detection to identify irregular patterns and potential security threats.
- Predictive Maintenance: Utilizing AI for predictive maintenance of airport infrastructure is a critical aspect. By analyzing historical data, machine learning models can predict the maintenance needs of essential equipment, such as baggage handling systems and security scanners. This proactive approach minimizes downtime and ensures the continuous operation of critical systems.

- Optimized Resource Allocation: AI can assist in optimizing resource allocation by analyzing passenger flow data and flight schedules. By predicting peak hours and potential bottlenecks, airports can strategically allocate staff and resources to enhance operational efficiency. This includes streamlining security checks, baggage handling, and optimizing gate assignments.
- Enhanced Security Measures: AI-powered OCF can strengthen security measures by analyzing patterns and identifying potential security threats in real-time. Advanced image recognition technologies, coupled with machine learning algorithms, can enhance the effectiveness of surveillance systems, ensuring a safer airport environment.
- Passenger Experience Enhancement: Improving passenger experience is a crucial goal for airports. AI can personalize services based on individual passenger preferences, providing real-time information about flight status, gate changes, and baggage location. Chatbots and virtual assistants can further enhance communication and provide assistance to passengers.

In conclusion, an AI-Powered Operation Control Framework for big data platforms in airports is essential for optimizing operations, ensuring security, and enhancing passenger experience. The integration of machine learning algorithms, predictive maintenance, and optimized resource allocation are key components for the success of such a framework.

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8 . Real-time Analytics, Multimodal Deep Learning, and Sentiment Analysis using Social Media Datasets

Real-Time Social Media and Multi-modal Analytics: Real-time social media and multi-modal analytics involve the analysis of diverse data types, including text, images, videos, and other forms of content, in real-time or near real-time. Here are some key aspects and methodologies:

Data Collection and Preprocessing:

- Real-time data collection from social media platforms involves using APIs (Application Programming Interfaces) to gather data as it is generated.
- Pre-processing steps involve cleaning and structuring data, handling noise and outliers, and converting unstructured data (such as text or images) into a format suitable for analysis.

Text Analytics:

- Natural Language Processing (NLP) techniques are employed to extract insights from textual data. This includes sentiment analysis, topic modeling, and entity recognition.
- Real-time text analytics often involves streaming processing frameworks like Apache Kafka or Apache Flink.

Image and Video Analytics:

- For images and videos, deep learning models such as convolutional neural networks (CNNs) are commonly used for object recognition, scene understanding, and emotion detection.
- Real-time processing of image and video data might involve using frameworks like TensorFlow or PyTorch, optimized for quick predictions.

Multi-modal Fusion:

- Integration of information from different modalities (e.g., text, image, video) is crucial for a comprehensive understanding. Fusion techniques combine features extracted from various modalities to provide a more holistic view of the content.
- Methods include late fusion (combining results after separate analysis) and early fusion (integrating features at the input level).

Real-time Processing:

- Technologies such as Apache Storm, Apache Flink, and Apache Kafka are often used for real-time data processing. These frameworks support stream processing, enabling the analysis of data as it flows in.

Social Network Analysis:

- Analyzing the relationships and interactions between users on social media platforms is essential. Graph-based approaches and network analysis methods help identify influencers, detect communities, and understand the spread of information.

Visualization and User Interface:

- Developing intuitive dashboards and visualization tools for end-users to interpret the real-time analytics results is crucial. This often involves web-based interfaces or custom applications.

Literature:

“Multimodal Research in Vision and Language: A Review of Current and Emerging Trends” is a survey paper discussing research trends in multimodal deep learning. The authors begin by stating that we perceive the real world in a “multimodal” form and that we get information from multiple sources. For example, when watching a video of someone speaking we see the video of the person talking and we identify what the person is saying. Hence, the intersection of vision and language. This has triggered the emergence of the Visual-Language (VisLang) research area. The authors categorize VisLang tasks into three major categories: generation, classification, and retrieval. The generation tasks include visual question answering, visual captioning, visual common sense reasoning, and visual generation. The classification tasks include multimodal affective computing. The retrieval tasks include visual retrieval. The authors also describe two additional classes which they classify as “other” and those two tasks are vision-language navigation and multimodal machine translation.

It is common to observe a combination of visual and textual information on social media platforms. In the study “Convolutional Neural Networks for Multimedia Sentiment Analysis,” Cai and Xia proposed convolution based networks for separately encoding unimodal pieces of information and then amalgamating them through another convolution model. In another study with the title “Cross-Modality Sentiment Analysis for Social Multimedia,” the authors used probabilistic graphical models along with hyper-graph models for analyzing independent features to effectively capture the interdependencies in heterogeneous modality spaces.

9 . Lidar Based Passenger Flow Tracking

Lidar (Light Detection and Ranging) technology has been widely used for various applications, including tracking and monitoring passenger flow in public spaces such as airports, train stations, and transportation hubs. Lidar sensors emit laser beams and measure the time it takes for the light to return after hitting an object, creating a 3D map of the environment.

Methodologies in Lidar-Based Passenger Flow Tracking

Point Cloud Processing:

- Lidar sensors generate point clouds representing the surfaces and objects in the environment. The first step in many Lidar-based tracking systems involves processing these point clouds to identify relevant features, such as people, obstacles, or structures.
- A presentation by James Hays called "3D Point Processing and Lidar" provides an overview of point cloud processing methods and 3D object detection.

Object Detection and Tracking: Object detection algorithms are used to identify individuals within the point cloud data. Tracking algorithms then follow the detected objects over time, allowing for the monitoring of their movement and interactions. Kalman filters and other tracking methodologies are often employed.

Feature Extraction: Extracting relevant features from the point cloud data helps in characterizing the movement and behavior of passengers. Features might include speed, direction, density, and spatial distribution.

Real-Time Processing: Many applications require real-time processing for effective passenger flow tracking. Lidar systems need to handle data streams in real-time, making efficient processing algorithms crucial for timely and accurate tracking.

Integration with Other Sensors: Lidar data is often integrated with information from other sensors, such as cameras, infrared sensors, or Wi-Fi systems, to enhance tracking accuracy and provide a more comprehensive understanding of passenger flow dynamics.

Point Cloud Processing Methods

The four most well-known methods for point cloud processing are Pointnet, Voxelnet, LaserNet, and PointPillars.

"PointNet: Deep Learning on Point Sets for 3D Classification and Segmentation" introduces the Pointnet method. Point cloud is a type of geometric data structure with an irregular format. Because of its irregular format, researchers transform point cloud data to regular 3D voxel grids or collections of images. This causes problems because the data becomes unnecessarily voluminous. PointNet is a type of neural network that directly consumes point clouds and it provides a unified architecture for applications ranging from object classification, part segmentation, to scene semantic parsing. It was introduced in 2017 and it shows strong performance on par or even better than state of the art.

The paper “VoxelNet: End-to-End Learning for Point Cloud Based 3D Object Detection” introduces VoxelNet, which is a generic 3D detection network that unifies feature extraction and bounding box prediction into a single stage, end-to-end trainable deep network. An advantage of this method is that it removes the need of manual feature engineering for 3D point clouds. This study was published in 2018 and it produces state-of-the-art results in LiDAR-based car, pedestrian, and cyclist detection benchmarks.

“LaserNet: An Efficient Probabilistic 3D Object Detector for Autonomous Driving” introduces LaserNet, which is a method for 3D object detection from LiDAR data for autonomous driving. Similar to the VoxelNet method, the LaserNet method also identifies objects and entities using 3D boxes. Experiments show that LaserNet has a better runtime performance than VoxelNet. However, VoxelNet has better object detection performance than Lasernet. Another difference between VoxelNet and LaserNet is that VoxelNet uses voxel-based point processing while LaserNet uses range image point processing.

“PointPillars: Fast Encoders for Object Detection from Point Clouds'' introduces the PointPillars method. The distinct quality of the PointPillars method is that it uses bird’s eye view point processing. The introduced method is described by the authors as “a novel encoder” which utilizes PointNets to learn a representation of point clouds organized in vertical columns (pillars). Recent literature suggests two types of encoders; fixed encoders tend to be fast but sacrifice accuracy, while encoders that are learned from data are more accurate, but slower. Experiments show that PointPillars outperforms previous encoders with respect to both speed and accuracy by a large margin. The PointPillars method outperforms VoxelNet for each task on the KITTI test 3D detection benchmark. However, VoxelNet outperforms PointPillars one out of nine tasks on the KITTI test BEV detection benchmark.

10 . Literature Review about Data Analytics in Luggage Control Systems

Baggage Vision (Siemens): It is a camera-based solution for optimizing sorting processes. Cameras capture images of each passing piece of baggage and use optical character recognition (OCR) technology to decipher the barcode, baggage item number, destination, and flight number. This allows fully automatic processing of a large number of baggage items – even if no corresponding baggage source message (BSM) is available. This increases recognition rates and reduces delays in baggage handling.

BagsID : BagsID provides different solutions for airports, airlines and ground handlers.

- API based SaaS and easily integrated airport infrastructure
- Baggage recognition system by capturing images in baggage from at strategic points.
    - Data collected from bag tells something about its features, wear, damage, and other characteristics.
    - These features are combined with geolocation, business rules and specific information about a journey.
    - No privacy-sensitive information about passengers or persons, only information about the baggage object.
- Identify, validate, match, extract and store data from baggage

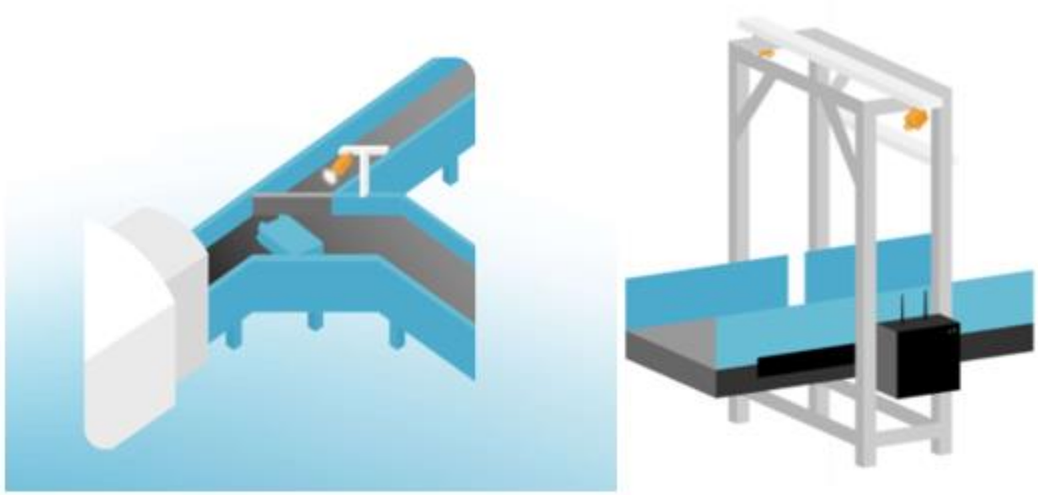

Image 1: BagsID baggage identification system

İmage retrieved from: https://www.bagsid.com/development/bagsid-airports

Baggage identification and tracking (Cloudflight): Camera systems mounted at key locations of the baggage transport logistic process such as check-in counters, before and after security checks, at aircraft loading docks

System is divided into two parts in order to decrease network load and to work in real time:

- A small and cost-effective camera and image processing services
  - Object Detection
  - Instance Segmentation
  - Object Fingerprinting
- A centralized identification and tracking service.
- The central server receives object fingerprints from the image processing services and stores them in a central database. By comparing these fingerprints – a quick and easy operation – the server can easily compare the current detection of baggage with the previous detection, thus creating a complete audit trail.

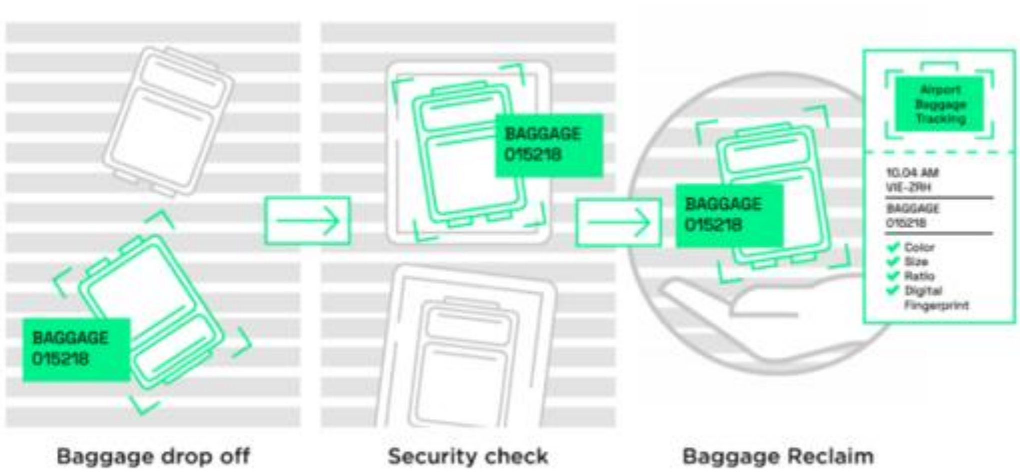

Image 2: Cloudflight baggage identification system

İmage retrieved from: https://www.cloudflight.io/en/project/where-optical-tracking-defeats-barcodes-and-rfid/

Literature Review:

A Siamase Neural Network For Non-Invasive Baggage Re-Identification (2020) [1]: The model in this work is able to estimate the baggage similarity: given a set of training images of the same suitcase (taken in different conditions), the network predicts whether the two input images belong to the same baggage identity.

X-ray baggage screening and artificial intelligence (AI) (2022) – European Commission [2]: This publication is a Science for Policy report by the Joint Research Centre (JRC), the European Commission's science and knowledge service. The use of image processing and pseudo colours to assist human operators was introduced, and they identified two different kinds of alarm-based assistance: — using X-ray transmission data to infer density and effective atomic number of scanned items, and raising an alarm if those properties match those of known threat materials; — using computer vision and machine learning techniques to detect prohibited objects. They briefly introduced another technique for material classification and detection, namely X-ray diffraction (XRD) technology, which is based on X-ray diffraction patterns that are specific for different materials.

Airline baggage classification/recognition and measurement based on computer vision (2022) [3]: This work focuses three different methods: a baggage classification recognition method based on Convolutional Neural Network (CNN) model, a baggage measurement algorithm using a combination of two-dimensional (2D) image and three-dimensional(3D) point cloud, and their realizations in an embedded platform.

Baggage Recognition and Collection at Airports (2022) [4]: This paper proposes a solution to the baggage recognition and collection process at the airports. Security of the passenger's luggage becomes a major question at airports during deplane and standing near the belts to collect the luggage. As nobody likes to stand and check each bag which is similar or identical to theirs, this paper worked on finding a solution to this problem.

Region to Global Vision Transformer for Baggage Re-Identification (2023) [5]: In order to effectively improve the performance of baggage re-identification, a region-to-global Transformer network (RGViT) is proposed.

Highly Imbalanced Baggage Threat Classification (2023) [6]: Some frameworks based on deep learning have been suggested to effectively detect contraband items in the baggages. However, these approaches primarily suffer from the issue of class imbalance, where prohibited objects are rarely seen in the real world compared to harmless baggage content. This paper proposes a novel classification network optimized with the novel compound balanced affinity loss function to address the class imbalance.

Analysis of RFID technology usage for luggage management in the airline industry [7]: This paper explores the role of radio frequency identification (RFID) in the airline industry, focusing on its application in tracking passenger luggage. RFID is seen as a valuable technology for enhancing customer service and reducing costs in the competitive and margin-driven commercial airline sector. The analysis examines two airlines to understand the factors influencing RFID adoption and its impact on luggage management. The study concludes that while RFID is essential, it alone is not adequate for airlines to achieve a competitive edge in the dynamic airline industry.

Smart Luggage Tracker [8]: This article discusses the potential benefits of implementing Radio Frequency Identification (RFID) technology in the aviation industry to address the issue of luggage mishandling. The proposed system involves Smart RFID tags, a cloud server, and a secure algorithm to generate tags attached to printed luggage labels. The tags store passenger and airline details, enabling step-by-step luggage tracking at check-in and check-out locations through RFID readers. Real-time location information is stored in a cloud server, and passengers can access their luggage details, including arrival time, location, and net weight changes, by entering a unique RFID code on a website. This system aims to provide passengers with accurate and timely information about the status and location of their luggage.

Smart Airline Baggage Tracking and Theft Prevention with Blockchain Technology [9]: This paper addresses the reduction of baggage mishandling in the aviation industry, aligning with IATA's Resolution 753 that mandates smart technology adoption by member airlines. The proposed system integrates RFID tags with management reporting systems to enhance baggage performance. Recognizing potential challenges in inter-airport connectivity, the paper advocates the use of blockchain technology to streamline luggage handling and management systems over the cloud. The framework introduced employs blockchain to securely store and process luggage data, enabling passengers to track their belongings in real-time from any location through the public cloud space. The innovative approach aims to leverage IoT, Cloud, and blockchain technologies to meet IATA's resolution and improve overall baggage handling efficiency.

Baggage tracing and handling system using RFID and IoT for airports [10]: This paper highlights the potential benefits of implementing Radio Frequency Identification (RFID) and the Internet of Things (IoT) in the aviation industry, particularly in baggage handling. It addresses common issues such as mislaid, lost, and damaged baggage by proposing a secure system using smart RFID tags and IoT, based on a cloud server. The system includes a prototype with check-in and check-out processes, employing a secure algorithm for generating RFID tags with passenger and airline details. RFID readers at check-out areas enable step tracking of baggage, preventing loss. Real-time position tracking via IoT and a unique ID accessible to passengers ensures efficient and secure baggage handling. The proposed system aims to save time, enhance security, and provide cost-effective solutions, ultimately leading to increased customer satisfaction.

Baggage Tracking Using RFID and Blockchain Technology [11]: The aviation industry faces significant financial losses due to the mishandling of luggage, costing airlines hundreds of millions annually. While airlines are responsible for damaged or lost baggage, passengers encounter complexities in claiming reimbursement within specific time frames dictated by airline policies. The proposed Baggage Tracking System, utilizing RFID and Blockchain, aims to address these issues. RFID tags enable real-time luggage tracking, with checkpoints updating a transparent blockchain record. This system enhances transparency and efficiency, reducing compensation costs for airlines and providing passengers and airlines with on-the-go luggage tracking capabilities. Ultimately, the proposed system seeks to streamline baggage management, benefiting both airlines and passengers.

Internet-of-Things-augmented dynamic route planning approach to the airport baggage handling system[12]: This paper proposes a novel approach for dynamic route planning in airport baggage handling systems, integrating real-time information on baggage location and device disruptions through IoT technologies. Utilizing the Hierarchical Cooperative A* algorithm as a core, the proposed algorithmic framework adapts to changing system conditions, generating conflict-free baggage routes. Validation with a real airport case demonstrates a 10% efficiency improvement over decentralized heuristic algorithms, and a 5% reduction in average baggage throughput time when real-time information is considered.

Deep Reinforcement Learning for Route Optimization in Baggage Handling Systems [13]: This paper addresses common issues of traffic congestion and deadlocks in Baggage Handling Systems, typically caused by static shortest path routes. It introduces a proof of concept using a Deep Reinforcement Learning method, specifically the Double Deep Q-Network, to optimize routing in a simplified model of a Baggage Handling System. The results demonstrate that the Double Deep Q-Network method outperforms both statically and dynamically computed Dijkstra's shortest path algorithm in terms of efficiency, using fewer steps on average to route a set of items in the tested environment.

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11 . Collaborative Business Models in the Transportation and Logistics Industry

A comprehensive seaport logistics platform creates a rapid and efficient logistics flow for cargo volume between terminals, container transport, and logistics centers (CFS) where Busan Port functions. And CFS plays a crucial role in seaport logistics, and the process of consolidation of CFS supports that individual LCL (Less than Container Load) shipments are grouped into containers, making it more efficient and cost-effective to transport them compared to shipping individual smaller boxes. In simpler terms, it's a warehouse where smaller shipments from different exporters or importers are grouped together to fill a standard shipping container before being loaded onto a ship or transported further inland. This reduces transportation costs for both shippers and carrier. And deconsolidation process supports that the CFS unpacks the container and sorts the individual shipments for onward delivery to their final recipients upon arrival at the destination port. Overall CFSs play a vital role in streamlining the movement of LCL cargo, making seaport operations more efficient and cost-effective for both shippers and carriers as shown below.

- CFS refers to a container operation site, which is a distribution centre that stores and operates cargo to vanning, devanning, and sort cargo into containers.
- CFS is the intersection of international trade by "containers" and domestic "general cargo", where various cargo information and information necessary for import and export are created and managed, and its importance is increasingly emerging as a logistics centre that performs important functions to connect and facilitate logistics flow in the front and rear.
- In the case of export cargo, the cargo is stored after loading at the CFS, moved to the container yard and shipped to the ship, and in the case of imported cargo, it is classified and stored through the CFS at the container yard and transported inland.

The challenges facing the digital transformation of CFS platform indicated in the figure 1 are enhancing operational efficiency through “Data linkage between stakeholders” and “Logistics optimization”. Furthermore, interrupted information sharing among stakeholders frequently causes idle time, such as frequent waiting times, and losses due to inefficiencies caused by lower loading rates of ships and trucks.

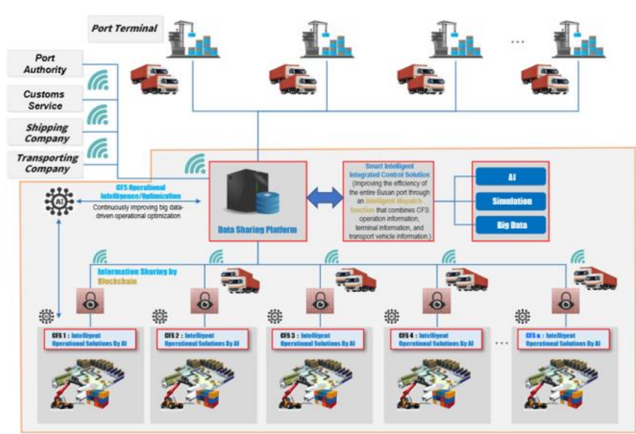

Figure 1 Business relationships of CFS and Transportation in Seaport Logistics

In a situation where inefficiency problems are serious due to information sharing disconnection between various stakeholders, this task aims to develop a reliable data linkage platform that can safely share information in warehouse, transportation, and related logistics processes between operators to realize data linkage between various actors.

- The function of seaport logistics (e.g., Busan Port) is to carry out the CFS and CY of the terminal and the hinterland behind it, where containers are unloaded and shipped for direct ships. Operational digitization and efficiency improvement between them are a major source of competitiveness in the country's ports.
- The driving force behind Port's ability to function properly in the midst of the logistical turmoil is due to the CFS's buffering of the volume of goods in the back hinterland area.

The container transportation and CFS business model is an important factor in supporting logistics activities centered on seaport and providing logistics services related to various companies. Container transportation and CFS at seaport play a big role in the development of the domestic and foreign trade and logistics industry. Figure 2 indicated the functional views on data federation and interoperability model to support seaport logistics service environment.

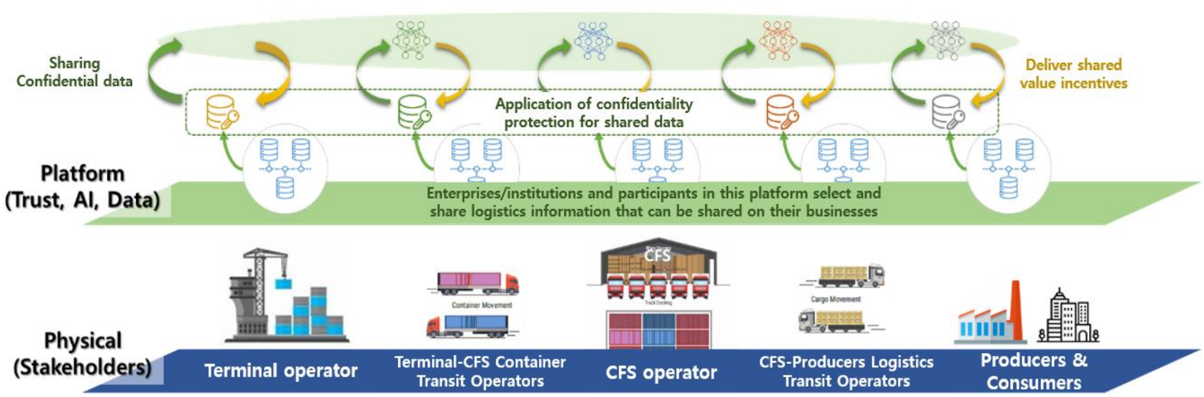

Figure 2 Data federation and interoperability model in in Seaport Logistics Platform

By collecting and linking individual data of CFS systems, the data processing on open data platform of seaport logistics service environment is achieved intelligently and smartly by creating a data sharing platform that allows multilateral data access, preparing data standards, and linking data necessary for port logistics.

And in a situation where inefficiency problems are serious due to information sharing disconnection between various stakeholders, the interoperability provisioning task indicated in figure 3 aims to develop a reliable and seamless data linkage platform that can safely share information in warehouse, transportation, and related logistics processes between operators to realize data linkage between various actors.

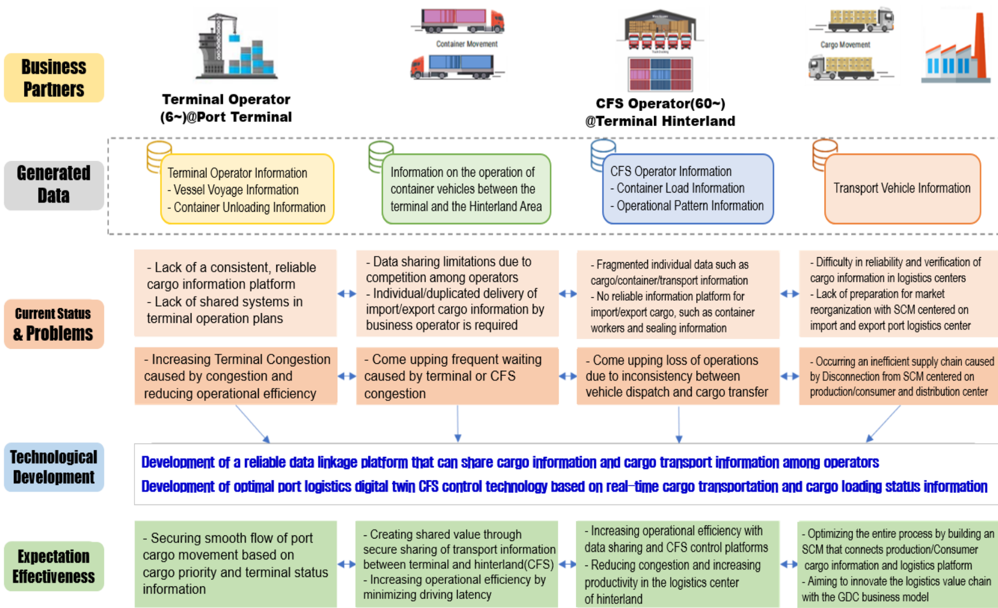

Figure 3 Functional Model to Support Seamless Data Consistency and Reliable Data Linkage in Seaport Logistics System

12 Development of AI-Powered Intelligent Logistics Service Platform with Data Trust and Blockchain

A container freight station(CFS) in the hinterland of the port terminal plays a crucial role in connecting the port terminal with providers/customers in the port logistics. It stores various cargoes, including import and export containers, and manages container information. However, due to the limited information shared among various stakeholders in port logistics, including the port terminal, significant delays and unnecessary waiting times occurs during the container handling process. As a consequence, the operational efficiency of the entire port logistics system is compromised due to significant delays and unnecessary waiting times in the container handling process.

The time delays in the port logistics system primarily occur during the container rehandling process. Cargo containers are loaded and stored in multiple tiers, and if a container designated for export is positioned in a lower tier rather than the top tier, it necessitates moving all containers stacked above it before it can be exported. This process is referred to as container rehandling. The underlying issue stems from limited information exchange among stakeholders in the port logistics flow, resulting in a shortfall in effective control and planning management of logistics flow.

To address the inefficiencies in port logistics, Korean consortium aims to approach the issue through the following two methods.

- To enhance the reliability and efficiency of information sharing among various stakeholders in the logistics flow, Korean consortium aims to integrate blockchain into the port logistics system. This ensures that data shared across the network is immutable and easily verifiable, fostering trust in the data exchange among port logistics stakeholders. By integrating blind computing into the blockchain framework, the Korean consortium provides functionality to process encrypted data on nodes without disclosing the content of confidential data such as cargo, competitive data of businesses, and personal data of customers. The functionality, ensuring data privacy for all participants, facilitates access to essential information such as container status, and schedules. This not only enhances trust but also establishes the foundation for improved logistics planning and flow control through collaborative data sharing, fostering a more integrated logistics ecosystem.
- Korean consortium aims to enhance logistics efficiency by developing technology that facilitates effective control and planning management of logistics flows based on shared information. By utilizing data such as container import/export schedules, vehicle information, and loading status within CFS warehouses provided by various port logistics stakeholders, the consortium will develop optimal container placement decision technology. This technology is designed to minimize occurrences of container rehandling, thereby reducing waiting times in the port logistics. Additionally, it will optimize the workflow of the entire logistics process, including port terminals, container freight station, and providers/customers, leading to improved efficiency in the overall logistics flow.

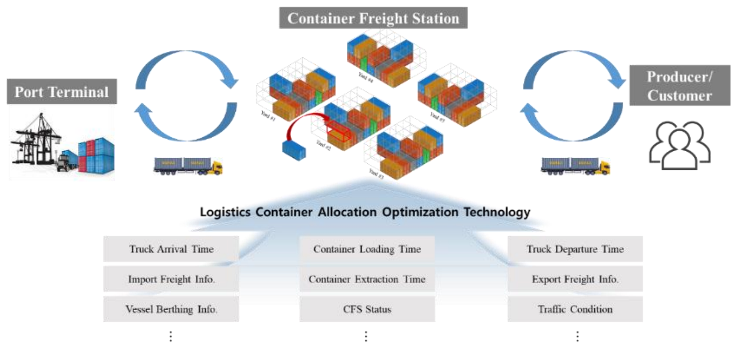

Figure 4 Overview of logistics container allocation optimization technology

12.1 Logistics container allocation optimization

Utilizing shared logistics data such as cargo container information and vehicle information, Korean consortium intends to develop intelligent technology that dynamically arranges cargo containers within the hinterland container freight station based on import/export request plans. This technology is designed to reduce waiting times caused by container re-handling, achieving this by adjusting container arrangements in advance through the analysis of historical import/export patterns and processing time modeling. The effectiveness of developed technology will be evaluated by measuring waiting times for various import/export scenarios.

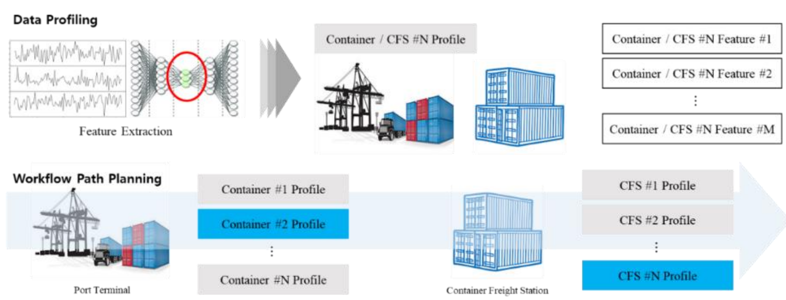

Figure 5 Overview of logistics workflow optimization technology

12.2 Logistics workflow optimization

Korean consortium is set to develop dynamic logistics workflow optimization technology, aiming to effectively manage logistics processes under diverse scenarios encountered during the seaport logistics transport. Initially, data profiling technology will be adapted to derive feature vectors from shared data by stakeholders (shippers, transportation companies, container yards, etc.), including container information, transportation vehicle details, and container yard loading statuses. Based on the feature vectors, the technology will identify the logistics flow status and dynamically control the logistics workflow to minimize waiting times in alignment with the container import/export plan. The effectiveness of this technology will be assessed through an evaluation of improvements of logistics workflow efficiency across various scenarios.

13 . Intelligent Logistics Service Platform

We intend to create platforms and elements that derive an optimal logistics environment by safely sharing and analysing data generated by various stakeholders according to logistics flow.

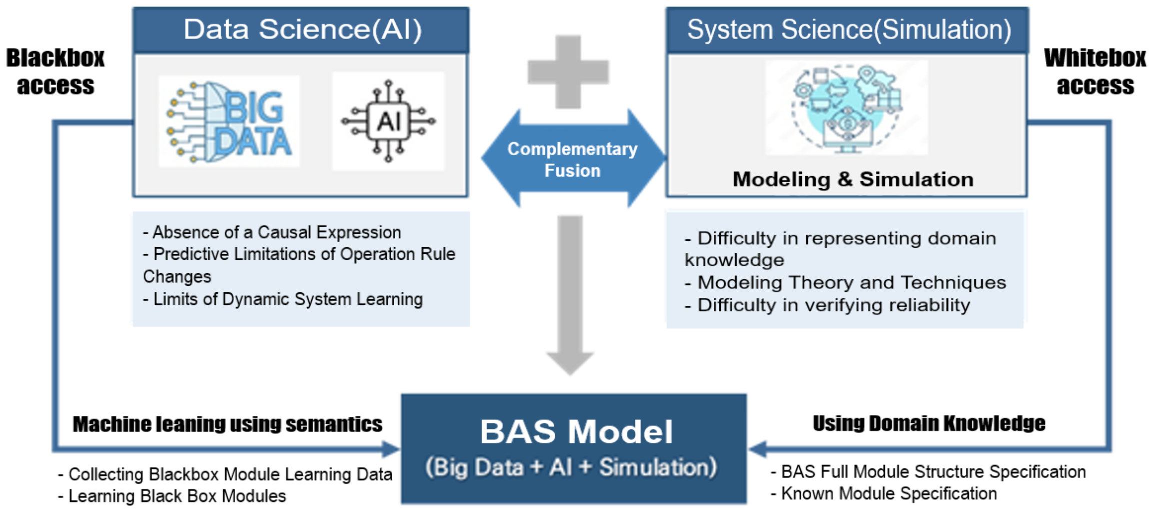

Figure 6 Intelligent Seaport Logistics Platform to Support safely sharing and analysing data generated by various stakeholders

An intelligent digital twin platform that combines big data (B), artificial intelligence (AI), and simulation (S) technologies based on Modeling & Simulation Engine.

- Traditional data science focuses on the correlation between data, and mainly uses artificial neural networks to learn predictive models, so there was a limit to the expression of causal relationships between data, and at the same time, predictive models using data science sometimes have poor predictive performance when predictive performance or operating rules change in dynamic systems including time series.
- On the other hand, modelling a predictive model based on system science requires a full understanding of the knowledge of the field, and even if the model is completed, there is a limit to model verification only with scientific formulas.
- BAS-based modelling complements the aforementioned limitations with model design based on explicit causality in system science and data-based machine learning and model verification in data science.
- When prediction performance degrades due to changes in the model's operating environment, it can be used immediately through model re-learning without model redesign.

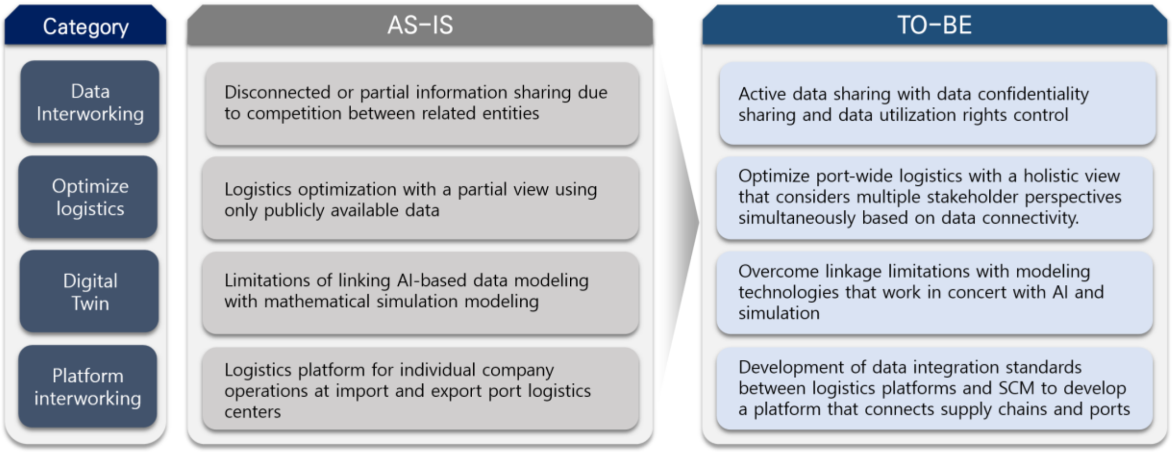

Figure 7 Enhanced Features of Intelligent Seaport Logistics Platform in terms of Four Categories

The platform will show an increasing importance of the hinterland industry and the need to introduce advanced IT technologies as the volume of goods increases as indicated in figure 7.

- (Need to introduce information security technology to connect services from terminals to CFS) In order to link information, there is an urgent need to secure trust in multilateral information security and the reliability of information changeability, so it is urgent to introduce information security-related technologies such as blockchain.
- (The need to adopt artificial intelligence (AI) and simulation technologies to handle increasing volumes) There is an urgent need to introduce artificial intelligence (AI) and simulation technology to achieve port logistics optimization based on linked logistics information. In particular, the development and application of IT solutions to handle increasing cargo volumes by utilizing limited port infrastructure and resources is an urgent task to be solved.
- To the end, its research and development will be focused to support Confidential Data Sharing for secure data sharing and utilization on multiple CFSs participating organizations (Stakeholders)