VOL.45

AIRPORT INSIGHTS REVIEW : CES(CONSUMER ELECTRONICS SHOW) 2023 WINTER vol. 45

AIRPORT INSIGHTS REVIEW

2023 WINTER vol. 45

TOPIC
CES and Incheon Airport

AITRI FOCUS
Incheon Airport XR Metaverse Connects the Virtual and Real Worlds

CARD NEWS
Status of Public Transportation in Incheon International Airport

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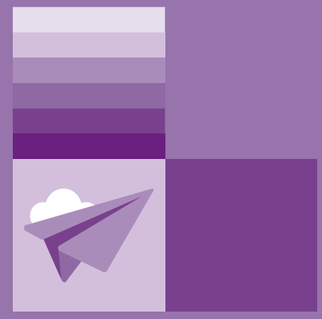
TOPIC



In a first for an airport, Incheon Airport presented to CES our intelligent airport operation model based on metaverse and digital twin, and a smart airport service model that utilizes robot and autonomous driving.

CES and Incheon Airport

Mi-jo Kwon
Incheon International Airport Corporation
(Airport Industry Technology Research Institute)

Q How did Incheon Airport become the world's first airport to participate in CES, and what was the preparation like?

The Consumer Electronics Show (CES) is the world's largest IT trade show, and is an event in which global companies like Samsung, Google, Microsoft, and many more introduce and promote new technologies. As a gateway to the IT powerhouse that is Korea, Incheon International Airport provides travelers with world-class services using numerous cutting-edge technologies. Incheon International Airport Corporation planned the Incheon Airport Pavilion at CES, not only to provide services to travelers who utilize the airport, but also to raise global awareness of the diverse technologies that our airport utilizes. In a first for an airport, Incheon Airport presented to CES our intelligent airport operation model based on metaverse and digital twin, and a smart airport service model that utilizes robot and autonomous driving. We were ultimately assigned a space in the main LVCC hall following an evaluation by CTA, the organizer of CES. There was a heated debate over what concept should comprise the Incheon Airport Pavilion at CES. Ultimately the decision was made to show the airport itself. We were able to stand out from other booths, as the image of our airport drew a considerable number of visitors, 6,000 over the four-day exhibition period. Being the first airport in the world to participate in CES resulted in a lot of attention both at home and abroad. By exhibiting a future airport concept and blueprint, Incheon Airport was able to reinforce its brand marketing and enhance its image as an innovative technology leading airport.

Q What was displayed at the CES 2023 Incheon Airport Pavilion?

The CES 2023 Incheon International Airport Pavilion concept was to present a vision of future airports by leveraging a metaverse that spans the virtual and the real. We prepared a pavilion where visitors can observe and truly experience the application of new technologies and services in an airport, such as AI, facial recognition, and UAM, which are technologies of the future, through a range of contents, allowing visitors to have a more genuine experience.

To address the constantly changing airport service paradigm, Incheon Airport is developing a smart pass. Through this travelers can conveniently register their facial information on their mobile device before departure, and can also register their facial information at kiosks positioned throughout the airport, in a process that takes just three minutes. Once they have registered for facial recognition, travelers do not need to show their passports at check-in, departure, boarding gates, or duty-free stores. The facial recognition rate has reached 99.9%, and the accuracy is improving thanks to AI-based deep learning. The most advantageous aspect of the smart pass is that travelers can move through the exclusive line more quickly by reserving the bag drop zone and departure time in advance. By the end of 2024, the smart pass service will be available throughout Incheon Airport.

"My Airport" is a business concept that provides various off-airport services at Incheon Airport. It connects transportation networks of logistics businesses to public check-in systems built by Incheon International Airport Corporation, such as AirCUS and CUSS. Baggage check-in is available in a variety of locations, including airport parking lots, transporta-

tion hubs, city hotels, railway stations, and homes, as well as areas surrounding the airport, and there are plans to gradually extend this service from 2023 to 2030. Travelers who use My Airport can fly empty-handed and save time at the airport, allowing them to enjoy city tours and duty-free shopping in their leisure time. Biometrics, self-driving, and IoT remote guiding technologies will be integrated into My Airport, realizing unmanned technologies step by step during the Home Drop stage in 2030.

Virtual Incheon Airport is a virtual experience service based on virtual reality (VR). An airport's immense size, intricate interior construction, and complex entry and exit procedures can be intimidating for many travelers. But now, you can now freely travel around the virtual Incheon Airport from anywhere in the world using your smartphone, and explore numerous airport contents. You can, for example, experience the traffic flow and processes of airport users in advance according to the departure itinerary, and can witness various performances and museum exhibitions in the metaverse world, which is fitting for a cultural and arts airport. Moreover, the user can browse through representative products of many brands at duty-free shops at Incheon Airport, and their avatars can actually try them on.

Urban Air Mobility (UAM) is a transportation system that uses electric vertical take-off and landing aircraft (eVTOL). A next-generation mobility service, it uses the sky as a corridor to convey people and cargo from city to city. UAM is powered by electricity, thus there are no carbon emissions, and it is quieter than conventional aircraft such as helicopters. A UAM airport shuttle is being prepared by Incheon Airport for environmentally friendly and convenient airport transfer. UAM is more than just a way to connect Incheon Airport to the future; it is a growing business that will lead next-generation mobility. The national aim for UAM commercialization in Korea is 2025.

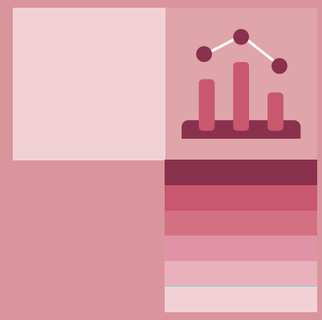
In addition, for passenger comfort, Incheon Airport has an indoor and outdoor parking guiding navigation system. Currently, the navigation system does not provide parking guidance; however, in the future, passengers utilizing the Incheon Airport Parking Navigation system will be able to pre-select an empty parking location and receive directions until parking is completed. This has the advantage of being able to provide route guidance using non-GPS technology even indoors, a GPS-shadow area. Also, parking information based on the needs of passengers can be accessed, such as parking locations for pregnant women, parking sites for the disabled, and parking areas for electric vehicles.

Incheon Airport is a vastly complicated facility with a complex structure, and most airport users struggle to find their way around. As a result, we created an augmented reality-based indoor navigation service that allows navigating even within the airport, which is a shadow zone for GPS. It has the advantage of being able to express the ideal route to the user's destination in augmented reality, even indoors, by leveraging VPS (Visual Positioning System)-based real-time positioning technology that matches the camera installed on the passenger's smartphone and 3D spatial information. In addition to these cutting-edge technologies, Incheon Airport is the world's first to offer a tailored VPS-based indoor route assistance service that combines passenger itinerary information such as flight number.

Incheon Airport is striving to provide virtualized data-based metaverse services such as AR navigation and VR Incheon Airport virtual experience, with spatial information serving as the foundation and core of these metaverse services. We created the "Incheon Airport Spatial Information Collecting Robot: AIR-RoP" to respond to facility changes in the 3D Spatial Information DB as the Incheon Airport expansion project advances. AIR-RoP is a geospatial data-gathering robot with remote control and autonomous driving capabilities, outfitted

with high-precision geospatial data scanning equipment, and it will be constantly updated when the inside environment at Incheon Airport changes. In the future, we will create AIR-RoP 2, a robot that will create maps of Incheon Airport's external environment, to complete not only indoor and outdoor metaverse services but also digital twin technologies.

Finally, the future air traffic control system at Incheon Airport will be able to display a 3-dimensional control screen based on metaverse technology rather than the existing 2-dimensional control screen. By using a 3D visual control system, various scenarios can be implemented, such as providing the controller with unexpected situations to enable simulation training, allowing the controller to receive realistic training. Airport conditions can be checked without the controller checking the exterior environment by employing a 3D graphics engine to display weather and time in real-time. The three-dimensional high-precision position of aircraft can also be expressed, allowing for more accurate air traffic control and control training. Furthermore, utilizing this technology, the airport will transition to an accessible transportation system centered on small aircraft such as UAM as well as large passenger and freight planes in the future.. AIR



The Incheon Airport XR Metaverse service, a world first, is a passenger service that blurs the line between the virtual and the real and is expected to be publicly launched as a pilot service in the first half of 2023, following a trial period.

The Airport Industry Technology Research Institute will leap forward to become a research institute specializing in the field of global aviation.

Incheon Airport XR Metaverse Connects the Virtual and Real Worlds

Through integrating with technology such as digital twin, artificial intelligence, and big data, the metaverse has recently expanded from gaming and communication-focused services to broader industries such as aviation, finance, and defense. Notably, local governments in Korea and large-scale social overhead capital (SOC) are utilizing the metaverse to implement a wide range of public services and operating technologies. Incheon Airport, Korea's leading national SOC facility, also supported the Incheon Airport XR Metaverse Project, which aims to create a metaverse-based passenger service in conjunction with public and private entities such as Incheon Metropolitan City and Naver Labs. The development of the XR metaverse passenger service was concluded after an eighteen-month demonstration project.

The Incheon Airport XR Metaverse service, a world first, is a passenger service that blurs the line between the virtual and the real and is expected to be publicly launched as a pilot service in the first half of 2023, following a trial period.

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Senior Researcher

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Senior Researcher

Introduction

With the inauguration of President Suk-yeol Yoon came the announcement of 110 national tasks and the goal of achieving hegemony in the digital economy by fostering new industries such as the metaverse and digital platforms. Metaverse, an integrated information and communications technology (ICT), is developing as a "game-changer" and a crucial future growth engine that will usher in a new paradigm in multiple domains, including society, economy, education, and culture. In celebration of the 23rd anniversary of its founding, Incheon International Airport Corporation declared ten key tasks and announced that it would provide differentiated passenger services by establishing the Incheon Airport XR metaverse platform to enhance its competitiveness as a smart innovative airport. Through a public-private partnership with Incheon Metropolitan City and Naver Labs, Incheon International Airport Corporation has begun constructing the Incheon Airport XR Metaverse platform and is set to launch public services in 2023. In this Monthly Focus, we'd like to describe the composition and services of the Incheon Airport XR Metaverse platform, as well as its anticipated outcomes.

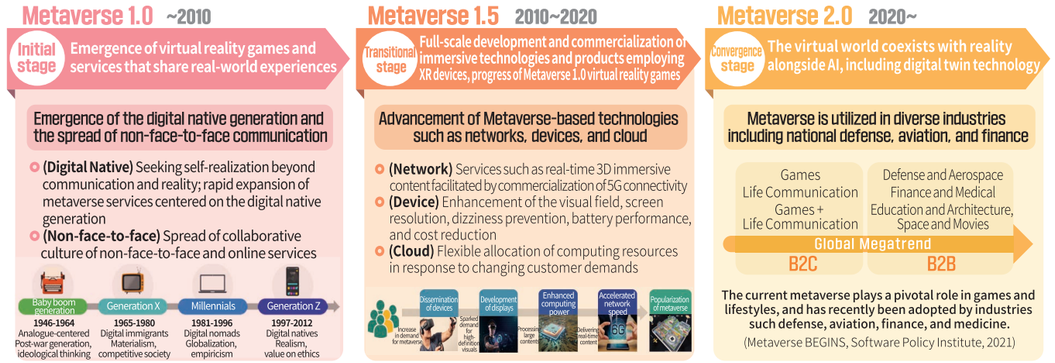


Figure 1. Transformation of the Metaverse

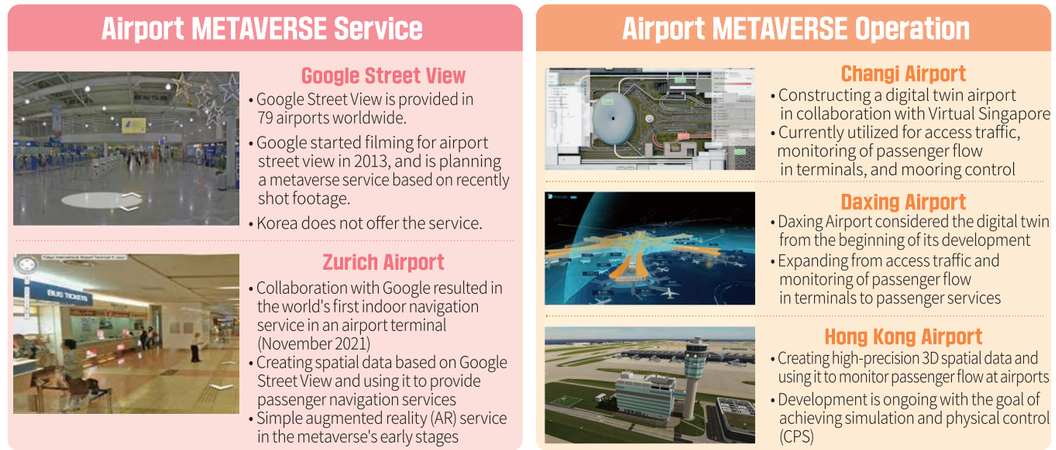


Figure 2. Metaverse Cases of International Airports

Metaverse

Metaverse is a portmanteau combining the words meta, meaning transcending, and universe, meaning actual reality. In its early days, it was used to supply games and communication-oriented services, but in recent years, it has expanded to industries such as manufacturing, finance, defense, and education by converging with existing technologies such as digital twin, artificial intelligence (AI), and big data. Multinational enterprises such as Meta (previously Facebook), Microsoft, and Nvidia have entered a heated competition to dominate the metaverse sector, and each nation is working to develop the ecosystem of the metaverse industry.

The metaverse consists of four components: augmented reality (AR), virtual reality (VR), lifelogging, and mirror worlds. The metaverse has a model defined as S.P.I.C.E.: Seamlessness, Presence, Interoperability, Concurrence, and Economic flow.

For airports, digital twin technology for airport operations

Task Name	XR Metaverse Incheon-Connecting Project
Project Objective	• Creating a 3D map and developing positioning-based XR metaverse service for Incheon's seven important regions, including Incheon International Airport • Creating a cloud-based service platform and SDK distribution environment by employing the greatest indoor and outdoor positioning technology in the country • Laying an ecosystem foundation for 5G-based demonstration and regional industrial growth based on service platforms, as well as ensuring global competitiveness
Project Scope	• Creating a 3D map and applying the positioning technology to seven major areas in Incheon Metropolitan City • Establishing 5G terminal and XR glass-based XR metaverse services • Developing, distributing, and supporting with AR service framework and SDK, open API, production tools • Providing services by developing two types of XR glasses and boosting support for convenience services for the socially disadvantaged • Demonstrating and validating 5G network-based services • Producing a 3D map and providing services for additional areas within the project's duration, with Incheon Metropolitan City's own investment
Managing Institution	Incheon Metropolitan City
Participating Institutions	NAVER LABS, SPTek, place8, InSignal, Incheon Airport, 인천교통공사, Incheon Tourism Organization, ITP 인천테크노파크, kt (consignment)
Project Period	• **Total research period:** May 1, 2021 - December 31, 2022(20 months)
Total Project Expense	• **1st year: KRW 6,094,662,400**(Government subsidy: KRW 4,000,000,000) • **2nd year: KRW 7,779,494,000**(Government subsidy: KRW 4,000,000,000) Expansion of services via local third-party enterprises through large-scale commercialization totaling KRW 14.18 billion

Figure 3. Overview of XR Metaverse Incheon–Connecting Project

Figure 4. Geospatial Data Acquisition Equipment of Naver Labs

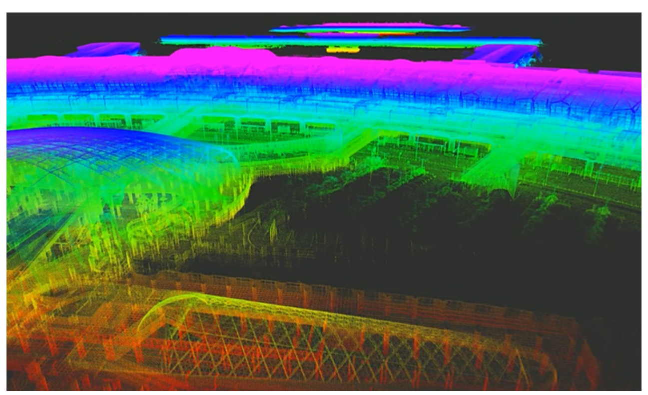


Figure 5. High–Precision 3D Spatial Data of Incheon Airport

was the primary metaverse service promoted, but recently, airport-encompassing metaverse services such as AR indoor navigation services based on the metaverse are being developed.

Incheon Airport's XR Metaverse Project

From May 2021 through December 2022, Incheon Airport sponsored the Incheon Airport XR Metaverse Project in partnership with the Ministry of Science and ICT, the city of Incheon, and Naver Labs. Incheon Airport developed high-precision 3D spatial information and fostered the growth of its AR indoor navigation service and VR virtual experience service on the metaverse platform.

First, the 3D spatial information acquisition equipment M1X and T2B from Naver Labs was used to generate precise 3D spatial information. The development of approximately 1.4 million m2 in 3D spatial information in indoor locations such as Incheon International Airport Terminal 1 and Terminal 2 and the concourse was accomplished in roughly a year.

The 3D spatial data consists of point cloud data and image (RGB) data, and is contained in Capture, a Naver Labs-proprietary format.

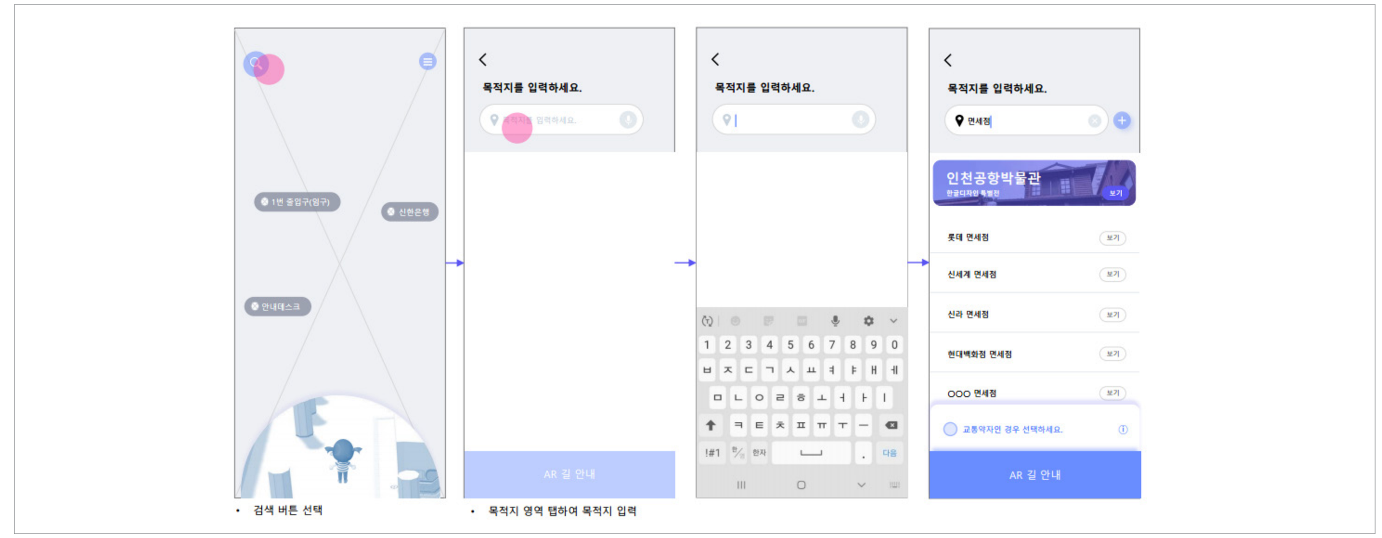


Figure 6. Destination Search in AR Indoor Navigation

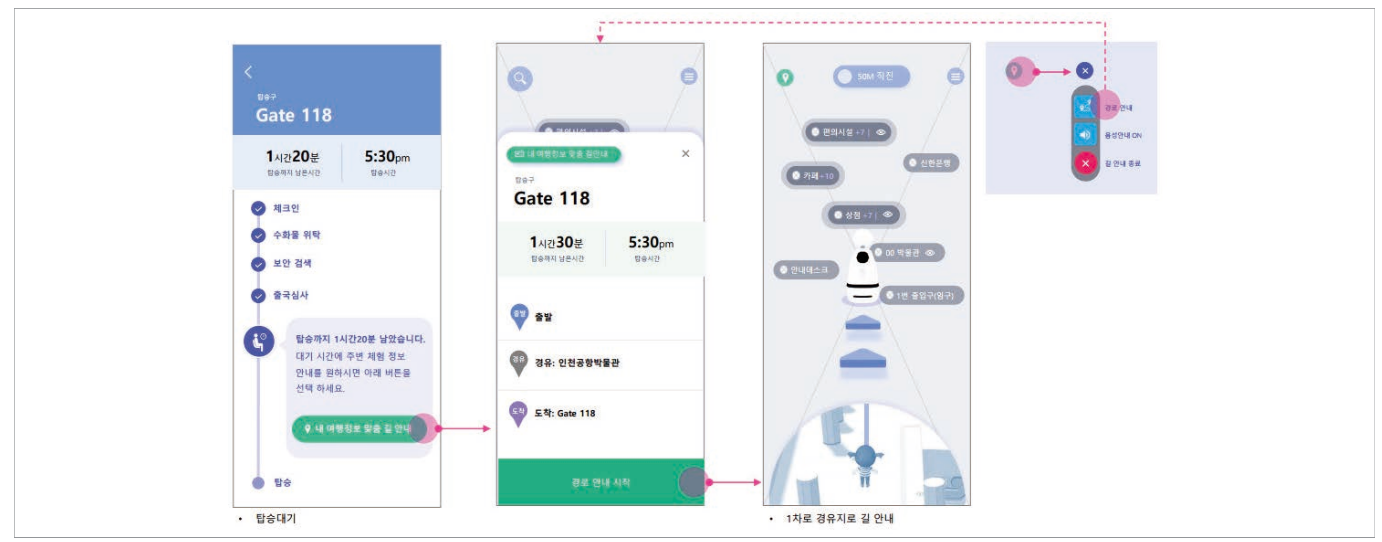


Figure 7. My Journey Search in AR Indoor Navigation

The Incheon Airport AR indoor navigation service provides visual positioning (VPS) utilizing 3D spatial information without the need for a separate communication infrastructure such as a beacon or Wi-Fi. In addition to location-based destination guidance, services such as a user-tailored navigation service that explains key procedures for boarding a flight and information on airport congestion utilizing Incheon Airport public data are supplied.

When the user initiates AR indoor navigation, the AR Core placed in the mobile phone is activated, and the current location is determined by matching the sent photo with the generated 3D spatial information.

The Incheon Airport AR indoor navigation can locate a user within one second with an error range of less than five centimeters, and can also identify the user's location in areas such as elevators and staircases. In addition, as the indoor navigation user interface is supplied with a 3D mini-map, it can be used

Figure 8. Virtual Incheon Airport

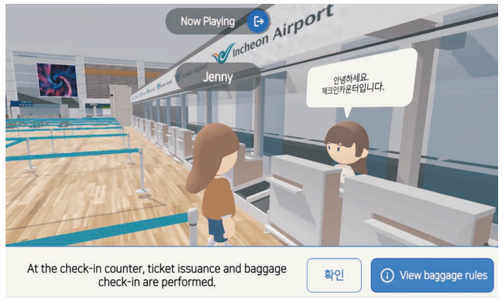


Figure 9. Virtual Incheon Airport

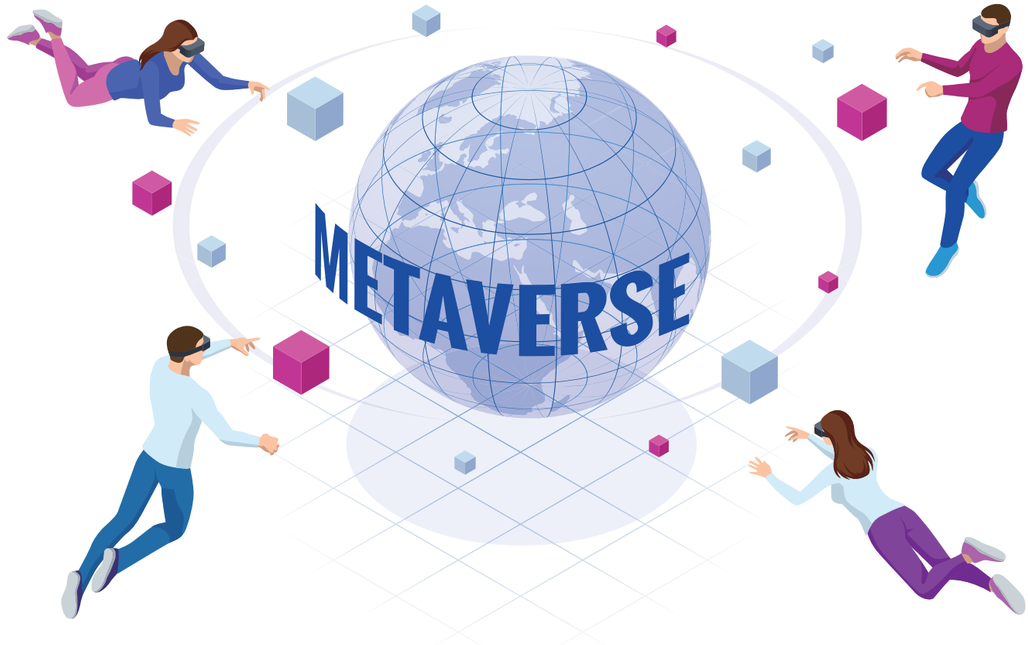
intuitively, as the user can quickly determine the route to the end destination and the location of the attractions.

Based on the point cloud, the Incheon Airport VR experience service established 3D modeling for the entirety of Passenger Terminal 1 and Terminal 2 and the concourse. Using avatars, users can experience the airport in advance of going there, and even engage with other virtual users. If Zepeto and Roblox are communication and gaming-focused services, then the Incheon Airport VR virtual experience service provides a virtual reality space with the same structure as Incheon Airport, improving users' sense of immersion.

In addition, if you have a flight ticket, you can experience everything from check-in through boarding at Incheon Airport, including the museums and duty-free shops, from the comfort of your own home.

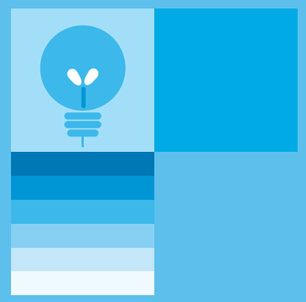
Conclusion and Prospects

For passenger service and digital transformation of operations, Incheon Airport is advocating the implementation of metaverse service. Incheon Airport promoted the space-focused Incheon Airport XR Metaverse project, which was distinct from the existing metaverse service, and concluded the demonstration project in December 2022. Through the project, Incheon Airport established precise 3D spatial information and developed space-oriented AR indoor navigation and VR Incheon Airport passenger services. The created augmented reality (AR) indoor navigation and virtual reality (VR) Incheon Airport passenger service will be delivered to the public as a pilot service during the first half of 2023, and will be the first services of their kind in the world. Currently, Incheon Airport is encouraging the introduction of operational methods based on created 3D spatial information, such as digital twin, and has completed the development of AIR-RoP (Robot Platform), a spatial information building robot for sustainable service and synchronization. Beginning in the second half of 2023, Incheon Airport aims to obtain and utilize geographical data independently. AIR



We deliver various themes of Incheon Airport and
the aviation industry easily and comfortably.

CARD NEWS



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What if the Urban Air Mobility(UAM) service is introduced at Incheon Airport?
We reviewed the UAM traffic demand and location.

Interesting Transportation Facts in Data Part 3: Use of ODTraffic Volume Data

Ph.,D. Yeongmin Kwon

How many passengers will utilize UAM at Incheon Airport?

Overview of Parts 1 and 2

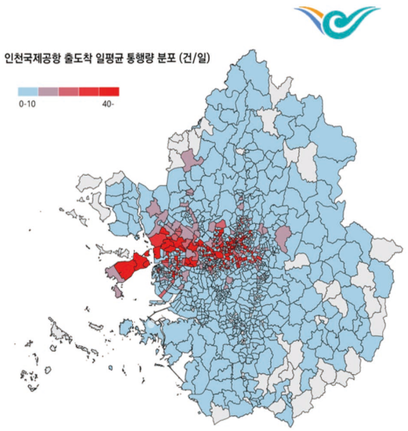
Analyzed traffic characteristics (origin-destination traffic volume, modes of transportation, etc.) of the floating population at Incheon Airport by utilizing mobile communication data, and smart card data

Big data close to the total number

Traffic volume by station-to-station

Assigned individual de-identified number

A sustainable analysis is feasible



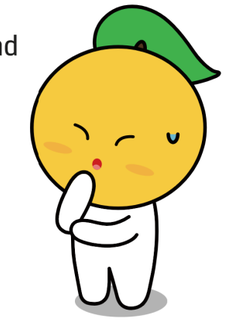
Part 3: Use of origin-destination traffic volume data

Let's forecast the UAM passenger demand and examine the location of the vertiport site to address one of the top 10 IIAC priorities for 2022, which is "development of a framework for the commercialization of urban air mobility!"

※ Urban air mobility, a three-dimensional urban air transportation system that connects the ground and the air, is a next-generation transportation system that can move people or freight over the city center in the sky. Our airport is supporting the commercialization of AM in 2025 to increase passenger accessibility and to be a leader in next-generation mobility.

How can we predict traffic demand?

⚠ Using a 4-step approach to predict traffic demand



The 4-step traffic demand model is the most widely used sequential model and is the most commonly used method for estimating transport demand, working based on the assumption that passengers make decisions sequentially.

It has the advantage of being able to represent reality by validating the outcomes of four steps: traffic occurrence > traffic distribution > mode selection > traffic assignment.

Traffic occurrence

Using socioeconomic data to predict traffic creation and arrival in traffic zones

Traffic distribution

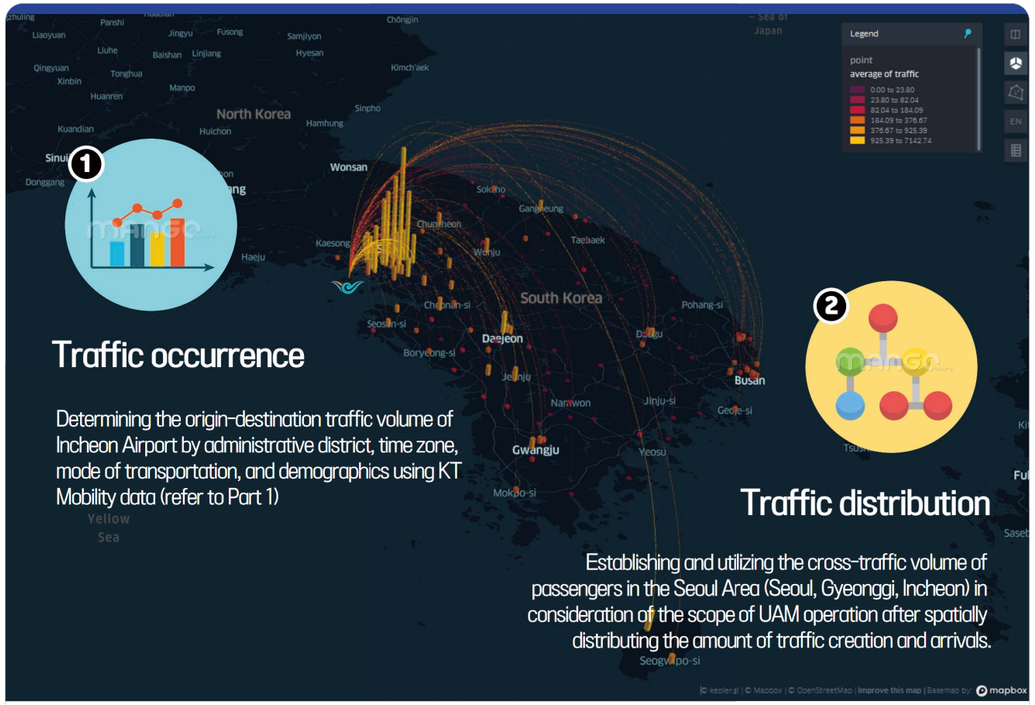
Establishing cross-traffic volume between traffic zones through the spatial distribution of traffic creation and arrival volume

Mode selection

Subdividing cross-traffic volume between traffic zones by user-selected modes of transportation

Traffic assignment

Creating a logical route connecting traffic zones and assigning traffic volume by mode to the route



Traffic occurrence

Determining the origin-destination traffic volume of Incheon Airport by administrative district, time zone, mode of transportation, and demographics using KT Mobility data (refer to Part 1)

Traffic distribution

Establishing and utilizing the cross-traffic volume of passengers in the Seoul Area (Seoul, Gyeonggi, Incheon) in consideration of the scope of UAM operation after spatially distributing the amount of traffic creation and arrivals.

Mode selection

For UAM, a new mode of mobility, it is impossible to obtain revealed preference data; therefore, a mode selection model is constructed utilizing survey-based latent preference data

2,604 passengers at Incheon Airport were surveyed to determine utility values for traffic duration, cost, transfer, etc. -> Analysis using a utility function

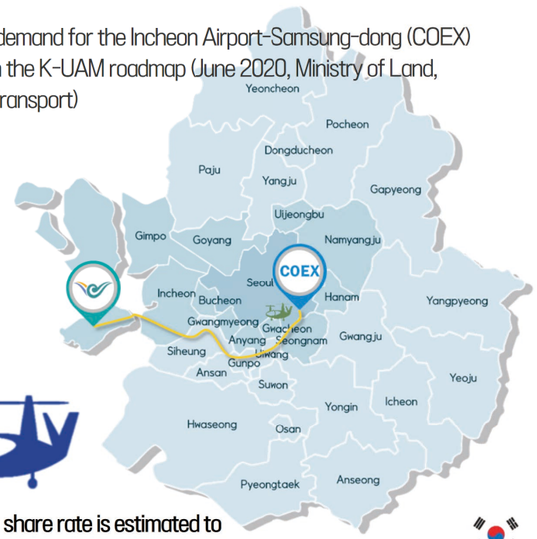
교통수단 구분	지하철	버스	택시	자가용	드론택시UAM
					
차내 통행시간	70분	70분	50분	50분	20분
차외 통행시간	15분	15분	5분	5분	15분
요금	10,000원	5,000원	60,000원	45,000원	90,000원
환승 횟수	0회	0회	0회	0회	0회
선택(√)	□	□	□	□	□

※If you are interested in the utility function-based methodology, please refer to Kwon et al. (2018) Evaluation of incentive policies for electric vehicles: An experimental study on Jeju Island, Transportation Research Part A: Policy and Practice, 116, 404-412 :)

Estimation of UAM demand for the Incheon Airport-Samsung-dong (COEX) segment specified in the K-UAM roadmap (June 2020, Ministry of Land, Infrastructure and Transport)

Traffic assignment

41.69% 37.72% 19.91%



Based on Samseong-dong, UAM's traffic mode share rate is estimated to reach up to 0.69 percent.

※The anticipated UAM share rate is based on 30 minutes of in-vehicle traffic time, 30 minutes of out-of-vehicle traffic time, KRW 200,000 in traffic cost, and one transfer based on UAM; as such, it may be modified as a result of changes in the external environment (traffic time of other modes of transportation, change in cost, location selection of UAM takeoff and landing sites, etc.)

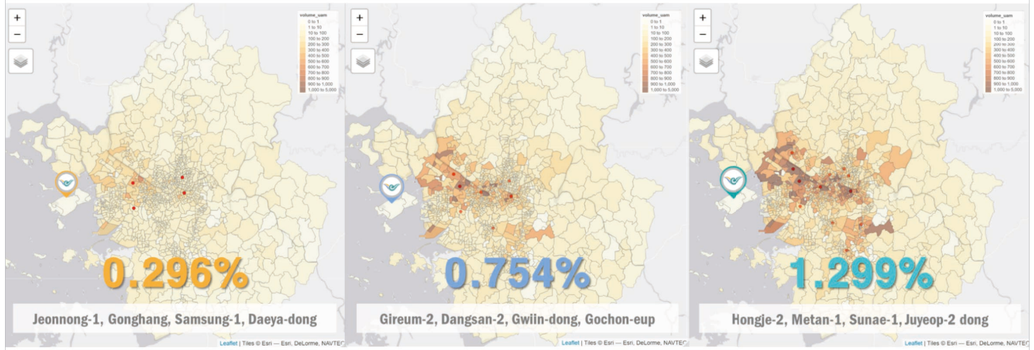
Where is the optimum takeoff and landing site in the Seoul area that optimizes Incheon Airport UAM demand, in addition to the routes provided by the government?

Optimal selection of a Vertiport site in the Seoul Area via the Genetic Algorithm technique

The genetic algorithm, a meta-heuristic methodology, is a probabilistic search strategy that imitates the natural selection and genetic principles that govern the evolution of organisms.

UAM Mode share ratio by optimal vertiport location for each step of the "K-UAM technology roadmap"

1st 단계 » 2nd 단계 » 3rd 단계



※ K-UAM Technology Roadmap (2021) information was utilized for the number of takeoff and landing sites at each stage, check-in time, and fare change, and the conversion rate parameter was the number of passengers at the Seoul Area airports in 2019

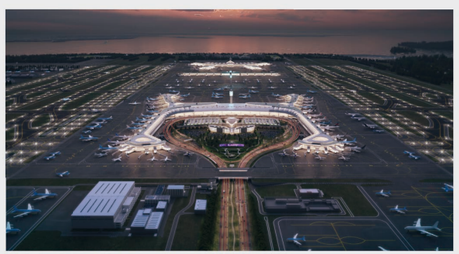
BOARDING PASS

The average number of one-way passengers/day based on the 1st stage (2025-)

355pax

※The Airport vertiport site is based on the upper area of the T2 parking lot

UAM



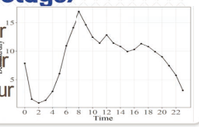
SEOUL ····· ✈ ····· INCHEON AIRPORT

Popular areas for takeoff and landing sites in the Seoul Area based on the 3rd stage (30-)

1 Samseong-1 2 Dangsan 2 3 Daeya dong

Average no. of passengers during peak hours: 28 (1st stage)

1st stage - 28 people/hour
2nd stage - 72 people/hour
3rd stage - 125 people/hour

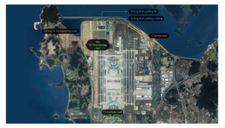


Deriving UAM demand by scenario (sensitivity analysis)

Estimating airport UAM traffic demand in response to changes in the external environment, such as traffic time, costs, and transfer frequency

Utilizing the airport development plan

Utilizing as data for UAM takeoff and landing site selection near Incheon Airport

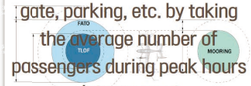


RESEARCH FINDINGS, CONCLUSIONS, AND IMPLICATIONS

Major Application Plan

Utilizing to calculate the capacity of takeoff and landing sites

Calculating the capacity of each facility such as FATO, gate, parking, etc. by taking the average number of passengers during peak hours into account



Deriving the role of UAM demand-based takeoff and landing sites

Determining types of takeoff and landing sites such as verti-stop, verti-port, verti-hub, etc. based on UAM's anticipated demand

Contributing to the establishment of a foundation for the commercialization of urban air mobility

Contributing to the formulation of UAM introduction and operation plans at Incheon Airport, and boosting the mode's competitiveness

Airport Industry Technology Research Institute

The Airport Industry Technology Research Institute's Policy Research Team collects, processes, and analyzes diverse big data relating to Incheon Airport to discover valuable insights.

※The Policy Research Team participates in the operations of the UAM T/F team and the UAM Team Korea Smart City Subcommittee. Please keep in mind that this card news is an excerpt that summarizes parts of the Institute's research findings in "The UAM Demand Prediction and Verti-port Location (Plan) Review."