

# 국외출장 결과보고서

기 간: 2022. 12. 11 ~ 2022. 12. 14

출장지: 싱가포르

출장자: 김동한

## I. 출장개요

1. 출 장 지: 싱가포르

2. 출장기간: 2022 12. 11 ~ 12. 14

3. 출 장 자

소속	직급	성명	비고
공간정보사회연구본부	연구위원	김동한	

4. 출장목적

☐ 빅데이터 기반 인공지능 활용 도시계획 기술개발 연구사업 수행을 위한 국제연구네트워크 구축

- 빅데이터 기반 인공지능 활용 도시계획 기술개발 연구의 성공적 추진을 위해서는, 빅데이터와 인공지능 기술을 도시계획 정책문제에 적용한 다양한 사례를 검토하고 시사점을 도출할 필요가 있는데, 이를 선도적으로 추진하고 있는 싱가포르의 정부기관을 방문하여 지식과 경험을 공유하고 향후 교류협력 방안을 논의

☐ 빅데이터 기반 도시지표, 인공지능 활용 시뮬레이션모형 개발 등을 위한 국제연구협력체계 구축

- 빅데이터 기반 인공지능 활용 도시계획 기술개발 연구는 다양한 빅데이터를 기반 도시지표와 인공지능 활용 도시모형을 개발하는 것을 중요한 목표로 하고 있는 바, 윈터 시뮬레이션 컨퍼런스에 참석하여 최신 연구동향을 파악하고 관련 전문가들과 협력체계 구축

## II. 출장일정

일정 (요일)	출발지	도착지	업무수행내용
12.11 (일)	인천	싱가포르	(16:35) 인천 출발 (22:20) 싱가포르 도착
12.12 (월)			(10:00-17:00) Smart Nation and Digital Government Office(SNDGO), Prime Minister' s Office(PMO) 방문 - 빅데이터 기반 인공지능 도시계획 기술개발 주제발표 - 빅데이터 기반 인공지능 도시계획 추진사례 청취 및 자문 - 연구협력 및 공동연구 수행방안 논의
12.13 (화)			(09:00-18:00) Winter Simulation Conference 2022 참석 - 인공지능 기반 시뮬레이션 추진사례 청취 및 자문 - 디지털 트윈 기반 시뮬레이션 추진사례 청취 및 자문 - 연구협력 및 공동연구 수행방안 논의
12.14 (수)	싱가포르	인천	(14:35) 싱가포르 출발 (22:00) 인천 도착

### III. 수행사항

#### 1. Smart Nation and Digital Government Office(SNDGO), Prime Minister's Office(PMO)

##### 1) 빅데이터 기반 인공지능 도시계획 기술개발 연구사업 주제 발표

- 국가 알앤디 연구개발 사업으로 수행중인 빅데이터 기반 인공지능 도시계획 기술개발 과제에 대한 소개 발표



## Research Overview

### ● Research Title: Development of Urban Planning Technology using Big Data and AI

### ● Period

- April 2022 - December 2026 (57 months), expected to be completed in 2026

### ● Research Grant

- Government funds 19,209 million KRW (approximately 15,000,000 USD)

(unit: million KRW)

	Total	'22	'23	'24	'25	'26
Amount	19,209	2,721	4,642	5,283	4,001	2,562

### ● Participating Institutes & Researchers

- 15 institutes & 178 participants in total (5 universities/68 participants, 3 government funded institutes/32 participants, 5 SMEs/71 participants, 2 local government funded institutes/7 participants)

### ● The achievements of this R&D project will belong to the state for public use

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## Research Background



● The advent of cutting-edge computing technologies such as big data and AI is leading our society and economic development.

● Big data and AI technology are used to solve socio-economic issues, and further to realize market innovation and national development. Urban planning is now required to actively find measures to utilize those technologies.

● The urban planning field needs to respond to various development demands and establish interactive urban plans, as well as set up and operate a system to evaluate previous plans.

● Based on these social backgrounds, this R&D project is to renew the existing urban planning process and its system through big data-based AI technology development.

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## Research Background

Category	AS-IS	TO-BE
Extend urban planning indicators	Example) Routinely distributing urban space demands after over-estimating population projections 	Example) Extend urban planning indicators based on evidence by using big data & AI 
Secure objectivity in urban management	Example) Gaps between urban planning and development 	Example) Secure practicality and objectivity in urban planning 
Secure measures to evaluate urban planning	Example) No evaluation measures for urban planning 	Example) Check the accomplishment rate of the plans by evaluating urban planning 

Currently, urban planning is conducted based on a qualitative analysis by individual local governments not capable of establishing urban planning on a scientific basis. However, establishing customized urban planning based on evidence and using big data and AI will bring higher practicality and build a positive relationship with future socio-scientific technology development.

## Research Vision

The first "official" and "nation-wide" introduction of big data and AI technology in urban planning



To realize interactive and smart city by objectifying and advancing urban planning

## Research Objectives & Achievements

Final Goal	Detailed Goal	Goal by stages					Achievements
Developing big data-based scientific & objective AI urban planning (concept & management plans) to respond to future social changes)	Technology Group 1 Developing big data-based urban diagnosis technology	STEP 1		STEP 2			Technology for utilizing & integrating urban big data
		2022 concept design	2023 Detail design & Initiating service platform development	2024 Completing service platform development	2025 Completing demonstration & Modifying service platform	2026 Improving platform operation & system	Urban diagnosis & outlook indicators
	Technology Group 2 Developing AI-based urban planning & supporting technology						Big data-based technology for urban diagnosis & outlook
							Technology to archive records of urban space & planning
							Supporting technology to establish big data & AI-based urban planning
							Technology to construct supporting systems for urban planning
							Urban planning monitoring system
	Technology Group 3 Developing technology to monitor urban changes & Conducting integrated demonstration	Developing basic technology & Constructing foundations		Developing applied technology & demonstration			Preparation demonstration & relevant systems of local governments

※ Three local governments to be demonstrated will be selected by inviting public participation in the 1<sup>st</sup> year

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## First-year Key Projects

Developing big data-based urban diagnosis technology
<ul style="list-style-type: none"> <li>- Research &amp; concept (detail) design to build big data</li> <li>- Algorithm concept (detail) design by diagnosis &amp; outlook</li> <li>- Concept (detail) design for urban diagnosis &amp; outlook service system</li> </ul>
Developing AI-based urban planning & supporting technology
<ul style="list-style-type: none"> <li>- Research &amp; concept (detail) design to build DB for urban space and urban planning</li> <li>- Algorithm concept (detail) design to establish and support big data &amp; AI-based urban planning</li> <li>- Concept (detail) design of supporting platform to establish urban planning</li> </ul>
Developing technology to monitor urban changes & Conducting demonstration
<ul style="list-style-type: none"> <li>- Concept (detail) design for urban planning monitoring service and system</li> <li>- Concept (detail) design to establish urban planning innovation framework</li> <li>- Inviting public participation &amp; appointing local governments for demonstration</li> </ul>

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- Open platform using big data-based AI



📍 The achievements of the R&D will be constructed as a cloud-based open platform (IaaS, SaaS, PaaS)\*

This will enable local governments and businesses to use the system and establish big data & AI-based urban planning at a minimum cost without building other systems

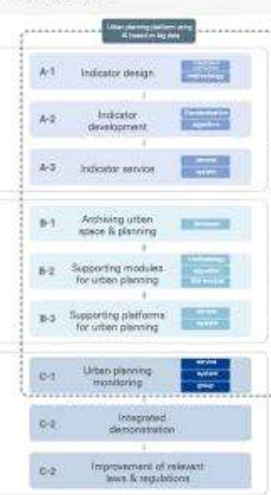
Technology Group 1

Technology Group 2

Technology Group 3



### Main Research



### Implementation Institute & Roles





## Research Implementation Structure & Roles



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## Linkage and Cooperation Strategy

Build communication channels & systems for feedback among AI experts, urban planning engineers, governmental & industrial institutes (central & local governments, businesses)



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## 📍 Strategic Plan: Creating Soft Infrastructures

- **Project implementation & Schedule management based on WBS**
  - Build a linkage system for project implementation by using common forms and sharing schedules
- **Seminars for subjects, semi-annual workshops, annual result-sharing & evaluation meetings, etc.**
  - Seminars for subjects, semi-annual workshops (Jul. & Dec.), annual result-sharing & evaluation meetings (Sept. – Oct.)
- **Build communication channels & feedback systems to work with external experts**
  - Establish & operate a general advisory committee
- **Establish international cooperation networks to strengthen research capability & promote results**
  - Centre for Advanced Spatial Analysis (CASA), Urban Big Data Centre, City Futures Research Centre

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## 📍 Strategic Plan: Creating Hard Infrastructures

- **Build constant collaboration systems using contact-free communication channels & cloud services**
  - Entrustment contract with Naver's cloud platform in progress (legal review for a multi-year contract)
  - Equipped with functions of bulletin boards, material-sharing, etc.
- **Prepare systems to obtain & share big data for R&D by sectors**
  - Move to the 1-1 R&D section by reflecting evaluations
  - Purchase by negotiation (developing a business model for public-private cooperation after the completion of the project)

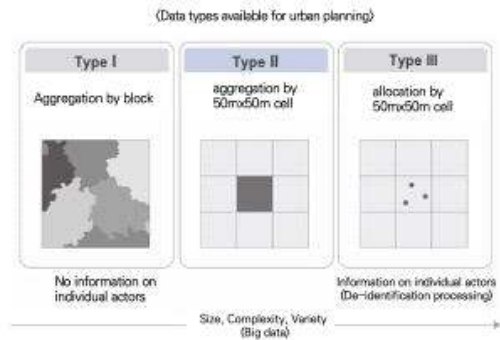


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## Data Searching & Securing Strategy

- Today's urban planning mostly uses statistical data as seen in "Type I" (not specific nor precise, limited in AI learning)
- This project will utilize big data such as "Type III" (more specific & precise, AI learning available).
- Besides existing population, this project will prioritize "public data" to develop it as urban planning indicators.
  - ※ Using and linking relevant system information including Korea Land use Information Platform (KLIP)
- "Private data" will be prioritized and purchased to be used, considering its necessity, usability, and sustainability.

※ Obtaining public data will be proceeded by the University of Seoul, and private data will be obtained by KRIHS.



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## Data Searching & Securing Strategy

- Public data (Univ. of Seoul)

- Building shape information
- Administrative boundary information
- Road shape information
- Subway stations/routes
- shape information
- Building register information, etc.

[illegible]

\* No cost for obtaining data, but R&D cost is required for data processing and standardization

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## Data Searching & Securing Strategy

### Private data (Korea Research Institute for Human Settlements\*)

- Floating population
- Personal income
- Corporate information
- Credit cards
- Logistics, etc.



\* Conducted projects for big data platform & center building, big data flagship, big data policy development, data analysis technology planning & verification, data voucher, etc. of the Ministry of Science and ICT.

※ Private data is not purchased for single use. By establishing an eco-system and suggesting appropriate business models, it will be used constantly after the completion of this R&D project.

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## Expected Results

- The capability to conduct big data & AI-based urban planning and autonomous administration will drastically improve at the national level, contributing to establishing evidence-based urban planning
  - Control inefficient space uses such as over-development, unsold houses, and overly unexecuted facilities which were caused by the over-estimated population
- Contribute to establishing the Digital Platform Government, a core policy task of the new administration, by preparing an expandable, open urban planning platform
  - Integrate all ministries based on big data & AI technology and unify administrative service platforms



(Expected results of Expanding local governments)



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## Discussion

- **Scopes of collaboration**

- Knowledge sharing
- Development of methodology

- **Forms of collaboration**

- Seminar
- MOU
- Joint research

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**Thank you!**

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## 2) Smart Nation and Digital Government Office(SNDGO), Prime Minister's Office(PMO) 수행연구 청취

- Smart Nation Digital Government Office는 싱가포르의 총리실 산하기구로서, 디지털 시대가 빠르게 발전함에 따라 스마트 국가의 진정한 의미를 실현하기 위한 제반 활동을 수행
- 디지털 정부, 디지털 경제, 및 디지털 사회가 정보기술을 활용하여 건강, 교통, 도시 생활, 정부 서비스 및 비즈니스에 변화를 가져오는 것을 추구
- 계속해서 인프라에 투자하고 기업과 시민이 배우고 발전할 수 있는 공유 개방형 플랫폼을 만들고 있음

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# About SNDGG

Transforming SG Through Tech

Our Key Pillars

Our Smart Nation Journey

A Secure Smart Nation

About Us

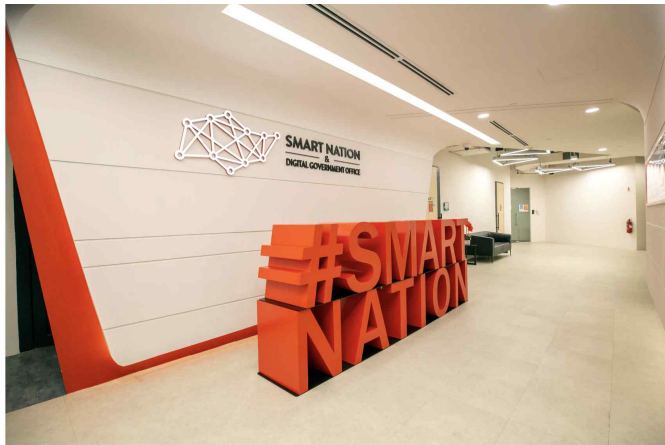
**About SNDGG**

Our Vision and Mission


SNDGG Ministerial Committee

SNDGO Senior Leaders

## Smart Nation Digital Government Group




The Smart Nation and Digital Government Office (SNDGO), under the [Prime Minister's Office \(PMO\)](#), plans and prioritises key Smart Nation projects and drives the digital transformation of our Government. It also builds long-term capabilities for the public sector, and promotes adoption and participation from the public and industry, to take a collective approach in building a Smart Nation.






- 이러한 일환으로 도시계획 분야의 디지털 전환, 빅데이터 및 인공지능 관련 기술을 활용하는 사례와 방법을 청취하고 논의 진행







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 AI in Urban Planning: 3 Ways it will Strengthen how we Plan for the Future

## AI in Urban Planning: 3 Ways it will Strengthen how we Plan for the Future

 Published: 01 September 2021
  Theme: Smart Planning
  Written by Huang Zhongwen

 Share

Written by Huang Zhongwen, Director, Design & Planning Lab (DPLab) at URA.

*In today's rapidly-changing and increasingly uncertain climate, planning for the future has become more important than ever. URA's planners will have to be more data-informed in the way we plan, to respond quickly to changes and identify optimal land and infrastructure options, so as to meet the needs of our communities and businesses of today and tomorrow.*



*Find out how advancements in Artificial Intelligence (AI) capabilities can be harnessed to support the development of robust plans that will safeguard Singapore for current and future generations.*

### Singapore and Urban Planning

Urban planning is not new to Singapore. Since the 1960s, Singapore's urban planning processes have been comprehensive and systematic, in order to ensure a high-quality living environment for all.

We were one of the world's first movers in using planning technology. And in our pursuit to meet the evolving needs of our citizens, we have sustained the relevance of our planning processes by keeping up-to-date with technological advancements and fusing our local innovations with global expertise.

Integration of computing technology for urban planning in Singapore began in the 1980-90s with the adoption of computerisation and Geospatial Information Systems (GIS). In the 2010s, we embarked on digitalisation to tap on the recent availability of digital data, data science tools, and advanced GIS capabilities such as 3D simulation and viewshed analysis. These have laid a strong foundation for us to further push the frontier of our digital toolkits with meaningful AI solutions.

Left: URA's ePlanner is a multi-platform geospatial urban planning analytics system that consolidates land-use planning information; Right: URA has developed an inventory of 3D models with different levels of detail for diverse urban design needs

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- Smart Planning


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## 2. Winter Simulation Conference 2022 참석

- 최신의 컴퓨터 시뮬레이션 이론, 방법론, 기술, 사례 등을 종합적으로 논의하는 컨퍼런스에 참석하여 국가 R&D사업 추진에 필요한 시사점을 도출하고 관련 전문가와 상호협력 방안을 모색

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After more than 50 years since its inception, the Winter Simulation Conference will be held in Asia for the very first time in 2022! Join us virtually, or on-site at Marina Bay Sands, the iconic landmark of Singapore, in one of the most dynamic and cosmopolitan cities in Asia from December 11-14, 2022!

The theme of 2022 WSC is derived from Singapore's Smart Nation initiative "Singapore Reimagined." The COVID-19 pandemic brought us a "new normal" and technological advances in the fields of robotics, artificial intelligence (AI), biotechnology, Internet of Things, quantum computing and virtual reality (VR) are changing the way humans live, work, play and communicate. Building on the "Smart Cities" focus of last year's conference, 2022 WSC will "Reimagine Tomorrow" to evaluate not just living in an urban future where cities are safe, green and environmentally-secure with seamless power, water and transportation networks, but also working in an environment where both sustainable high-tech manufacturing and novel services play an essential role.

Well-known for its efficiency in logistics services and in the midst of developing the world's largest next generation container port, we will look at Singapore's future logistics and port systems integration and how simulation provides a good way to help the country plan its next move.

In addition, with more than a dozen wafer fabrication facilities in operation or under construction in Asia's "Silicon Island," the Modeling and Analysis of Semiconductor Manufacturing (MASM) subconference will be given particular attention at 2022 WSC.

"Reimagine Tomorrow" relies on significant advancement from many fields such as modeling, experimentation and data analysis coming together to tackle various challenges. We invite scientific papers and case studies that highlight innovations in both theory and applications, with a specific focus on the use of not just simulation but also related technologies such as AI and VR.

A number of exciting changes will be implemented to make 2022 WSC even more attractive. Case studies will be integrated into the full paper tracks to enhance cross-fertilization between academia and industry, further supported by a Case Study Competition. The program roster will also be significantly enhanced to enable a productive hybrid format that accommodates the needs of virtual attendees from time zones across the entire globe.

WSC 2022 Program

All times are in +08.

Overview | By Date | By Track

Monday, December 12th

Tuesday, December 13th

Wednesday, December 14th

6:00am-7:30am

Estimation Techniques for Simulation Optimization

Central Limit Theorems for Constructing Confidence Regions in Strictly Convex Multi-Objective Simulation Optimization  
Fixed Budget Ranking and Selection with Streaming Input Data  
Policy Evaluation with Stochastic Gradient Estimation Techniques  
Simulation Optimization

Reliability Modeling and Simulation I

Shilpa Mohale

Spatial Agent-based Simulation of Connected and Autonomous Vehicles to Assess Impacts on Traffic Conditions  
Simulation as a Soft Digital Twin for Maintenance Reliability Operations  
Gaussian Process Model for a Water Cooled Centrifugal Chiller Using Both Manufacturer's and Operation Data  
Reliability Modeling and Simulation

Remote Military and National Security Applications

Supervised Machine Learning for Effective Missile Launch Based on Beyond Visual Range Air Combat Simulations  
A Meta-Heuristic Solution Approach to Isolated Evacuation Problems  
An Application of Automated Machine Learning within a Data Farming Process  
Military and National Security Applications

Simulation and AI Methodology I

Batching on Biased Estimators  
Distributional Input Uncertainty  
Simulation of Stance Perturbation  
Simulation and AI

Tutorial: Metamodeling for Simulation

Chris Kuhlman

Introductory Tutorials

Uncertainty Quantification

Empirical Uniform Bounds for Heteroscedastic Metamodeling  
Estimating Confidence Regions for Disruption Risk Measures and Their Gradients  
Overlapping Batch Confidence Regions on the Steady-State Quantile Vector  
Analysis Methodology

8:30am-9:30am

Operational Planning for Critical Patients

Vishwanathyan Girishan Prabhu

Simulation Model of a Multi-Hospital Critical Care Network

Virtual Room #10

Artificial Intelligence/Machine Learning in DSS I

High-Resolution Shape Deformation Prediction in Additive Manufacturing using 3D CNN  
A New Application of Machine Learning: Detecting Errors in Network Simulations  
Using Deep Learning for Simulation of Real Time Video Streaming Applications  
Data Science and Simulation

From Discovery to Production: Challenges and Novel Methodologies for Next Generation Biomanufacturing

Metamodeling for Variable Annuity Valuation: 10 Years Beyond Kriging  
Sequential Nested Simulation for Estimating Expected Shortfall  
Quantile Sensitivity Estimation through Delta Family Method  
Financial Engineering

Simulation: The Critical Technology in Digital Twin Development

Canan Gunes Corlu

Introductory Tutorials

Uncertainty Quantification

Zheny Zhang

Cheap Bootstrap for Input Uncertainty Quantification  
Distributional Discrimination Using Kolmogorov-Smirnov Statistics and Kullback-Leibler Divergence for gamma, log-normal, and Weibull distributions  
Combining Numerical Linear Algebra with Simulation to Compute Stationary Distributions  
Model Uncertainty and Robust Simulations

6:30am-7:30am

Digital Twins Applications

Digital Twins for the Dynamic Management of Blockchain Systems  
Real-Time Spatio-Temporal Databases: Bridging The Gap Between Experimentable Digital Twins And Databases  
Simulation as Digital Twin

Emergent Behaviors and Construction Labor Productivity

Chris Kuhlman

Identifying Correlates of Emergent Behaviors in Agent-Based Simulation Models Using Inverse Reinforcement Learning  
Agent-Based Modelling and Simulation of Multidimensional Impacts of Construction Labor Productivity Factors  
Agent-based Simulation

Virtual Room #11

A Tutorial On Combining FlexSim With Python For Developing Discrete-Event Simheuristics

Juan Fernando Galindo Jaramillo

details  
Introductory Tutorials

Machine Learning for Simulation in Construction

Accelerating Training Of Reinforcement Learning-Based Construction Robots In Simulation Using Demonstrations Collected In Virtual Reality  
Field-Based Assessment of Joint Motions in Construction Tasks with and without Exoskeletons in Support of Worker-Exoskeleton Partnership Modeling and Simulation  
Automated Integration of Infrastructure Component Status for Real-Time Restoration Progress Control: Case Study of Highway System in Hurricane Harvey  
Project Management and Construction

Maritime Systems II

Optimization of Hub-and-Spoke Maritime Network Considering Hub Port Failure  
Simulation-Optimization Approach for Integrated Scheduling at Wharf Areas in Container Terminals  
Combination of Simulated Annealing Algorithms and Minimum Horizontal Line Algorithm to Solve Two-Dimensional Pallet Loading Problem  
Maritime Systems

Urban and Local Transport

Manuel Auf der Landwehr

A Simulation-Optimization Model for Automated Parcel Lockers Network Design in Urban Scenarios in Pamplona (Spain), Zakopane, and Krakow (Poland)  
Combining Survival Analysis and Simheuristics to Predict the Risk of Delays in Urban Ridesharing Operations with Random Travel Times  
Simulation Platform for Testing and Evaluation of CAV Trajectory Optimization and Signal Control Algorithms Integrated with Commercial Traffic Simulation  
Logistics, Supply Chains, Transportation

8:30am-9:30am

Maritime Systems III

Feeder Ship Routing Problem with Tidal Time Windows  
Yard Template Planning in a Transshipment Hub: Gaussian Process Regression  
Maritime Systems

9:30am-10:30am

Maritime Systems Panel Discussion

details  
Maritime Systems

Virtual Room #15

Virtual Room #21

Virtual Room #26

Virtual Room #31

Virtual Room #36

Virtual Room #41

Virtual Room #46

Virtual Room #51

Virtual Room #56

Virtual Room #61

Virtual Room #66

Virtual Room #71

Virtual Room #76

Virtual Room #81

Virtual Room #86

Virtual Room #91

Virtual Room #96

Virtual Room #101





### 3. 종합 시사점

- 싱가포르의 Smart Nation Digital Government Office는 다양한 공공과 민간의 데이터를 체계적으로 수집하여 국가적 차원에서 이를 공유하고 도시계획, 스마트도시 등에 활용하기 위한 다양한 연구개발과 정책적용을 수행하고 있음
- 싱가포르는 도시국가로 우리나라처럼 다양한 도시와 도시문제가 있는 것은 아니기 때문에 기술의 정책적용이 상대적으로 복잡하지 않을 수는 있음
- 그럼에도 불구하고 빅데이터, 인공지능 기술 등을 실제 도시문제에 적용하기 위해서 범정부적 차원에서 접근하고 있는 방법은 벤치마킹하여 살펴볼 필요성이 있으며, 관련된 노하우를 서로 공유하기로 함
- 윈터 시뮬레이션 컨퍼런스는 컴퓨터 분야의 다양한 원천 기술을 다양한 응용 분야에 적용하여, 시뮬레이션 기술의 방법론 개발과 현실 적용을 도모하고 있음
- 도시공간 시뮬레이션 모형의 개발과 적용을 위해서는 다양한 분과학문의 전문가와의 협업을 통해 방법론을 개발하고 적용할 필요가 있음