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Singapore Maritime Institute partners stakeholders in R&D collaborations to drive maritime digitalisation and artificial intelligence

S$22 million to fund two maritime centres of excellence

The Singapore Maritime Institute (SMI) successfully held the 12th Edition of the SMI Forum at the Orchard Hotel today. Themed "Digitalisation and Artificial Intelligence: Sparking the Maritime Sector", the event's Guest-of-Honour was Mr Chee Hong Tat, Singapore's Senior Minister of State for Finance and Transport.

2 In his opening remarks, Mr Chee announced that SMI will be awarding an additional funding of S$12 million to Nanyang Technological University (NTU) to support the Maritime Energy and Sustainable Development (MESD) Centre of Excellence, as well as an additional funding of S$10 million over the next five-year period to the Centre of Excellence in Modelling and Simulation for Next Generation Ports (C4NGP).

Phase Two funding for the Maritime Energy and Sustainable Development Centre of Excellence

3 SMI will be awarding an additional S$12 million[1] to NTU over the next five-year period, to support the MESD Centre of Excellence's efforts to deepen research for 14 maritime decarbonisation R&D projects that were developed in Phase One for potential industry deployment in Phase Two.

4 The MESD will initiate joint projects on 16 R&D areas which it has identified with the Maritime and Port Authority of Singapore (MPA) and industry partners. These projects include trials on alternative fuels and energy sources[2], as well as associated adoption pathways.

Phase Two funding for the Centre of Excellence in Modelling and Simulation for Next Generation Ports

5 SMI will also be awarding an additional funding of S$10 million[3] over the next five-year period to the C4NGP, which is part of the College of Design and Engineering at National University of Singapore (NUS), to translate the Centre's advanced digital twinning technologies for adoption by local port and the maritime industry.

6 In its next phase, the C4NGP aims to create and share new knowledge with local and international industry partners via its digital twin software packages. Other R&D projects to be developed include Tuas Port's digital twin, advanced port operation planning systems, performance analysis of future automation systems, and a digital twin for haulier services in Singapore.

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[1] Please refer to Annex 1 for more information on Phase Two funding for MESD

[2] Alternative fuels and energy sources such as ammonia, methanol as hydrogen-carriers, biofuels, and electrification

[3] Please refer to Annex 2 for more information on Phase Two funding for C4NGP

7 SMI Chairman, Mr Wong Weng Sun, said, “SMI is pleased to support the Phase Two funding for MESD and C4NGP. The two centres of excellence form the repositories of deep expertise and knowledge in the respective areas of green shipping and next generation port, and have made significant R&D achievements since their establishment. In the next phase, the Centres will focus efforts on translating their rich R&D capabilities for industry adoption. They will continue their role in supporting and building a strong and vibrant research and innovation ecosystem through maritime R&D excellence.”

Harnessing AI for Maritime

Maritime AI Research Programme

8 In addition to supporting the Maritime R&D Centre of Excellence, SMI will be working on AI research programmes, maritime use cases and collaborating with AI institutions to implement AI applications in maritime. SMI has awarded S$4.78 million to the Agency for Science, Technology and Research’s (A*STAR) Institute of High Performance Computing (IHPC) to lead the Maritime AI Research Programme[4].

9 IHPC was identified as the suitable agency to lead given its deep AI expertise and experience in maritime R&D, and will use the funding to launch the first phase of the programme with a focus on maritime data excellence and AI modelling excellence as well as use cases. IHPC will co-develop the technologies in collaboration with other institutes of higher learning, research institutes, industry partners, and relevant public sector agencies in the maritime ecosystem.

Maritime AI Grant Call

10 Jointly launched by SMI and MPA on 28 April 2022, and supported by the National Research Foundation Singapore, the Maritime AI Grant Call[5] is a follow-up to the series of Memorandum of Understandings (MoUs) signed during the 2021 SMI Forum to address industry-wide gaps and opportunities arising from the increased use of automation and autonomy in the maritime industry. To kick-start this effort, SMI will be awarding grants to three proposals from NUS and Singapore Institute of Technology.

Memorandum of Understanding Signing with AI4Diversity

11 At the event, Mr Tan Cheng Peng, Executive Director, SMI, inked a two-year MoU with Mr Steve Nouri, Founder of AI4Diversity (AI4D), to promote the development of joint activities related to Maritime AI. Under the MoU[6], AI4D will advise SMI on Maritime AI initiatives, provide recommendations for the strategic development of Maritime AI R&D in Singapore, and facilitate the exchange of information on Maritime AI including results of research collaboration.

Strengthening Digital Safety and Security

12 To enhance the industry’s resilience against cybersecurity risks, SMI has awarded S$4.77 million to iTrust, Centre for Research in Cyber Security at the Singapore University of Technology and Design to develop a Maritime Testbed of Shipboard Operational Technology (MariOT)[7] system, in collaboration with the American Bureau of Shipping and Singapore Polytechnic’s Centre of Excellence in Maritime Safety.

13 The MariOT will be the world’s first industrial-grade cyber-physical platform equipped with essential shipboard operational technology systems to offer a safe and realistic testing

[4] Please refer to Annex 3 for more information on Maritime AI Research Programme
[5] Please refer to Annex 4 for more information on Maritime AI Grant Call
[6] Please refer to Annex 5 for more information on the MoU with AI4Diversity
[7] Please refer to Annex 6 for more information on MariOT

environment for cybersecurity technologies without disrupting actual vessel operations. The hybrid platform will be used to design and validate new cybersecurity technologies for deployment onboard ships, as well as to train maritime professionals and students through cyber exercises and drills.

Grooming R&D Talent through MPA Endowed Chair Professorship in Maritime Management

14 Matching NTU's contribution of S$500,000, SMI will contribute S$500,000 to an endowment fund for additional distributable income towards the MPA Endowed Chair Professorship in Maritime Management, which will replace the current MPA Professorship in Shipping Management that was first established in 2003 with an endowment of S$4 million by MPA.

15 The Endowed Chair Professorship will appoint a full-time Endowed Chair Professor to enhance maritime education with a strong base of faculty talents in Singapore, and drive the development of pedagogy and quality of academic modules through longer-term strategic plans for the Maritime Studies programmes. This will further enhance the quality of discourse, attract collaborations with international scholars and industry, and add greater intellectual and creative vibrancy to attract prospecting students to pursue a course of study and meaningful career in maritime.

16 Said Mr Teo Eng Dih, Chief Executive of MPA, "The MPA Endowed Chair Professorship will contribute to Singapore's maritime thought leadership and enhance the quality of maritime education. It will help build a pipeline of talent that Maritime Singapore needs to support future growth."

<End of Release>

About the Maritime and Port Authority of Singapore (MPA)

MPA was established on 2 February 1996, with the mission to develop Singapore as a premier global hub port and international maritime centre, and to advance and safeguard Singapore's strategic maritime interests. MPA is the driving force behind Singapore's port and maritime development, taking on the roles of Port Authority, Port Regulator, Port Planner, IMC Champion, and National Maritime Representative. MPA partners the industry and other agencies to enhance safety, security and environmental protection in our port waters, facilitate port operations and growth, expand the cluster of maritime ancillary services, and promote maritime R&D and manpower development.

For more information, please visit www.mpa.gov.sg/

About the Singapore Maritime Institute (SMI)

SMI is a joint effort by the MPA, the Agency for Science, Technology and Research (A*STAR) and the Singapore Economic Development Board.

Established in April 2011, SMI develops strategies and programmes to achieve its mission with key focus areas in sectors such as port, shipping and maritime services. SMI charts the maritime research strategy and promotes greater industry-academia research and development (R&D) collaborations to be undertaken in Singapore.

Through a whole-of-government approach, SMI drives initiatives with industry-wide impacts to enhance the overall competitiveness of the local maritime industry, and to strengthen R&D capabilities in support of Singapore as a global maritime knowledge hub.

For more information, please visit www.maritimeinstitute.sg

For media clarification, please contact:

Gerald Kheng (Mr)
Manager, Corporate Communications
Maritime and Port Authority of Singapore
Mobile: (65) 97115431
Email: gerald_kheng@mpa.gov.sg

Jacqueline Goh (Ms)
Senior Manager, Outreach and Corporate Communications
Singapore Maritime Institute
Mobile: (65) 9228 9032
Email: jacqueline@maritimeinstitute.sg

Annex 1: Phase Two funding for the Maritime Energy and Sustainable Development Centre of Excellence

Singapore Maritime Institute (SMI) has awarded a core funding of S$12 million to Nanyang Technological University (NTU) to support the Phase Two efforts of the Maritime Energy & Sustainable Development (MESD) over a five-year period from 29 September 2022 to 30 September 2027

Launched in October 2017 and jointly funded by SMI and NTU to deepen Singapore's maritime research and development (R&D) capability in the field of energy and sustainable development, MESD's mission was to deepen Singapore's maritime capability in the field of energy and sustainable development, with a focus on future port and shipping operations.

Phase One (September 2017 – September 2022)

MESD covered the following three R&D focus areas in Phase One:

- Energy management using energy management tools and waste energy recovery system for enhancing the performance of ports and ships.
- Emission management through alternate, clean energy or fuel and emission control and monitoring to provide solutions for port and ship operators to meet global standard and handle future regulations.
- Sustainable maritime operations to ensure that innovative approaches are practical and economically viable for ships and ports.

Some of the projects that had been undertaken in Phase One include:

- Ammonia as marine fuel in Singapore;
- Technical and operational feasibility of methanol fuelled vessels in China and Singapore;
- Bio-liquefied natural gas (LNG) in shipping industry decarbonisation;
- Study of alternative sources of energy for next generation multipurpose port;
- Sustainable biofuel pathway for maritime application; and
- Methanol as marine fuel for Singapore harbour craft

Phase Two (September 2022 – September 2027)

Building on the capabilities developed in Phase One, MESD plans to deliver high-impact research outcomes in phase two and be the key node for maritime decarbonisation R&D in Singapore. As a key node of research, MESD will deepen collaborations and co-create initiatives with industry and other research entities to build capabilities in maritime decarbonisation R&D in Singapore.

In the next phase of the centre's research work, MESD aims to focus on emissions management and decarbonisation of maritime operations. This shift in focus will support Singapore's energy strategy to switch to low-carbon alternatives. MESD's work will also help to develop the energy value chain to support both harbour operations and international shipping in Singapore.

MESD will also endeavour to drive technology translation and place additional effort to push novel concepts from research projects in Phase One to the next level of readiness towards industry adoption in Phase Two by actively seeking joint projects with industry partners and agencies. MESD has identified 16 R&D projects for Phase Two with inputs from MPA and is aligned with the recommendations from the Singapore Maritime Foundation's international advisory panel on Maritime decarbonisation.

Some of the R&D projects to be undertaken by MESD in its Phase Two include:

1. Bio-LNG for decarbonisation of international shipping
2. Ammonia bunkering operation safety, mitigation and environmental impact study
3. Methanol as a marine fuel
4. In-situ utilisation of carbon dioxide for shipboard application
5. Carbon capture utilisation and storage scale up and sea trial
6. Value chain and impact analysis of alternative maritime energy

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Annex 2: Phase Two funding for the Centre of Excellence in Modelling and Simulation for Next Generation Ports

SMI has awarded a core funding of S$10 million to support the Phase Two efforts of the Centre of Excellence in Modelling and Simulation for Next Generation Ports (C4NGP) for a five-year period from 2 January 2023 - 1 January 2028

Launched in January 2018 and jointly funded by SMI and the National University of Singapore (NUS), C4NGP was set up to maintain Singapore's maritime leadership by studying and analysing the most advance, innovative and efficient solutions around the world in the areas of maritime and port management system.

With Singapore working towards building a mega port, the Centre aims to conduct state-of-the-art research in next generation ports, bring about a significant impact on research and business development, be a globally recognised leader in port research, and translate research results into innovations for commercialisation.

Phase One (January 2018 – January 2023)

C4NGP covered the following four R&D focus areas in Phase One:

- Next Generation Virtual Port Platform
- Next Generation Sea-Port Interface Systems
- Next Generation Port Systems
- Next Generation Port-Land Interface Systems

Some of the projects that had been undertaken in Phase One include:

- Maritime Simulation Platform: Development of Simulation and Optimisation Platform (O^2DES)
- Collision Avoidance Advisory System
- Optimisation and Scheduling of Automated Guided Vehicle Battery Charging
- Optimal Location of AGV Transponders
- AGV Deadlock Prevention and Computation
- Yard Storage Management Strategies
- Equipment Deployment and Throughput Study for New Jurong Port

Key achievements for C4NGP over the first five years

C4NGP has developed digital twin(s) based on their in-house O^2DES framework. This framework has allowed companies to conduct planning, based on past, present and future simulated data. It has also reduced costs and increased productivity, without the need to carry out physical simulations or testing, saving time and resources.

C4NGP also hosted the 9th International Conference on Logistics and Maritime Systems and will be co-hosting the 2022 Annual Winter Simulation Conference which will be held in Asia for the first time in December 2022.

Phase Two (January 2023 – January 2028)

C4NGP aims to deepen the capabilities built in Phase One and introduce the Centre's value-added digital twinning technologies to the maritime industry for adoption. C4NGP also aims to take an active role and strengthen its leadership in global conferences and within its network, to enhance Singapore's international position as a global maritime knowledge hub.

C4NGP seeks to create and share knowledge with local and international industry partners, via its Digital Twin software packages that enable industrial process improvements; faster decision-making support; and sense-making using modelling-simulation-optimisation techniques, with machine-learning and artificial intelligence (AI) capabilities. C4NGP will also work on research projects that are linked to:

1. Development of Digital Twin 2.0
2. Projects related to Adjacency Connectivity beyond the Port

Some of the R&D projects to be undertaken by C4NGP in Phase Two nclude:

1. Tuas Mega Port Digital Twin Development
2. Advanced Port Operation Planning System for PSA and Jurong Port
3. Performance Analysis of Future Automation Systems for PSA and Jurong Port
4. Development of Digital Twin for Haulier Service for Singapore

Expansion into the international community

In Phase One, C4NGP shared the basic O^2DES framework with some of their PortML Alliance partners to test its capabilities. The Centre has since received constructive feedback and suggestions for further improvement.

In Phase Two, C4NGP plans to expand its presence within the region and beyond, through organising international conferences and symposiums in port and maritime research. One of these events is an international e-Conference on PortML Standards, which aims to invite like-minded and interested parties from the academia and related industries to participate and exchange ideas and views.

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Annex 3: Maritime AI Research Programme

*SMI has awarded S$4.78 million to the Maritime AI Research Programme for A*STAR's Institute of High Performance Computing (IHPC) to lead the development of Maritime AI*

The Maritime Artificial Intelligence (AI) Programme was initiated to develop a central node for driving a coordinated effort for Maritime AI research, build capabilities for the maritime industry and facilitate industry-wide adoption of AI and other related advanced digital technologies.

With its strength in AI and advanced computing, as well as experience in maritime R&D, IHPC was appointed to lead the development of Maritime AI in four pillars over two phases:

1. Maritime data excellence
2. AI modelling excellence
3. Computing excellence
4. Applied AI excellence

The research programme has been awarded S$4.78 million to launch its first phase, which will focus on data excellence and AI modelling excellence. At the end of the first phase, maritime data processing toolkits and maritime AI model toolkits would be available for evaluation and provide a foundation for the second phase of development. Some of the AI model toolkits would address the following use cases:

- Maritime traffic safety management
- Predictive maintenance
- Maritime emission monitoring and reduction

As the programme lead, IHPC will leverage on complementary strength and domain expertise of the institutes of higher learning and their centres of excellence, research institutes, industry partners and relevant public sector agencies to co-develop technologies and solutions for the maritime industry.

The industry partners supporting the programme include ABS (American Bureau of Shipping), DNV Singapore Pte Ltd, METIS Cyberspace Technology (Singapore) Pte Ltd, Nippon Kaiji Kyokai (ClassNK), NYK Group company MTI Co. Ltd. (Monohakobi Technology Institute), PSA Marine, ShipsFocus and Wärtsilä Singapore Pte Ltd.

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Annex 4: Maritime AI Grant Call

Launched on 28 April 2022 by SMI and MPA, and supported by National Research Foundation Singapore, the Maritime AI R&D Grant Call is a follow-up to the series of Memorandum of Understandings (MoUs) which SMI signed with Kongsberg Digital AS, RightShip and Wärtsilä Voyage Limited at the SMI Forum 2021 to cooperate on the Maritime AI R&D Programme.

The Maritime AI R&D Programme was established in 2021 to address industry-wide gaps and opportunities arising from increased use of automation and autonomy in the maritime industry such as data quality and integrity, systems security and integration, as well as to build up talent for modelling, simulation and AI for the maritime domain.

This grant call aimed to develop new AI algorithms, tools and applications that can be licensed, applied, and adopted by the industry and marinetech companies. SMI will be awarding three proposals under the grant call.

	Proposal Title	**Host Institution**
1	AI Based Vessel Risk Profile Estimation and Classification	National University of Singapore
2	Coupled Engine-Vessel Physics with Data Driven AI Models for Carbon Emissions Estimation	Singapore Institute of Technology
3	Smart ship fuel consumption and emission estimation: AI-based approaches and assessment of energy-saving devices and technologies	National University of Singapore

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Annex 5: MoU signing with AI4Diversity

Founded by Chief Data Scientist Steve Nouri, AI4Diversity (AI4D) engages and educates diverse communities about AI to benefit global society.

Through this MoU, AI4D will i) advise SMI on the Maritime AI initiatives; ii) promote the development of joint activities related to Maritime AI; and iii) provide recommendations for the strategic development of Maritime AI R&D in Singapore.

The scope of co-operation includes promoting and developing collaborations in:

- The development of joint research activities related to Maritime AI
- The exchange of information, including the results of research collaboration
- Joint conferences, seminars and workshops of mutual interest to both parties

The two-year MoU covers the aforementioned common areas of interest between SMI and AI4D, with each party securing separate and individual funding for any joint projects defined.

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Annex 6: Maritime Testbed of Shipboard Operational Technology Systems

SMI has awarded S$4.77 million to iTrust, Centre for Research in Cyber Security at the Singapore University of Technology and Design (SUTD) to develop a Maritime Testbed of Shipboard Operational Technology (MariOT) system in collaboration with the American Bureau of Shipping and Singapore Polytechnic's Centre of Excellence in Maritime Safety

The MariOT is a follow up to the guidelines on cyber risk management for shipboard systems that was delivered by iTrust in Phase One.

The objective of Phase Two is to develop a new maritime testbed of shipboard operational technology systems in SUTD which can be used for cybersecurity research, training, exercise and education.

This testbed supports the MTP Strategic Research Thrust 4 on Effective Maritime Safety & Security, which focuses on supporting Singapore to be a safe and resilient hub port and international maritime centre. It is also drawn up in line with SMI's R&D roadmap 2030 for Maritime Cybersecurity (Shipboard).

Project Significance

The testbed will be the world's first industrial-grade cyber-physical platform that contributes to efforts in enhancing Singapore's cybersecurity resilience, by supporting the design and validation of new cybersecurity technologies to protect maritime assets against cyber attacks. It also provides a realistic and safe environment to train and educate maritime professionals and students through cyber exercises and drills.

Project Collaborators

This project is in collaboration with American Bureau of Shipping and Centre of Excellence in Maritime Safety, Singapore Polytechnic.

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