FY2024 Grant for International Project Research IMI Joint Use Research Program Proposal

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所属・職名 UTM-CENTRE FOR INDUSTRIAL & APPLIED MATHEMATICS (UTM-CIAM), UNIVERSITI TEKNOLOGI MALAYSIA・DIRECTOR

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1.研究計画題目	Forum of Mathematics for Industry (FMfI 2024) and ISMI (2024)			
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3.種別	国際プロジェクト研究			
4.種目	研究集会（Ｉ）			
5.開催方法				
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7.研究実施期間	2024年09月09日～2024年09月11日			
8.キーワード	Mathematical Modelling, Convective Heat Flux, Stochastic Modelling, decision analysis & analytics, mathematical optimisation, non-linear programming, Bayesian Statistics			
9.参加者人数	112			

10.本研究で得られた成果の概要

The Forum of Mathematics for Industry 2024 (FMfI2024), held as part of the International Symposium on Mathematics for Industry 2024 (ISMI2024), convened 112 participants from academia, government, and industry across Japan, Australia, Indonesia, Singapore, Germany, Thailand, and Malaysia, with some joining virtually. Guided by the theme “Mathematical Evolution Guiding Industrial Innovation Futures”, the event provided a platform for addressing industrial challenges through applied mathematics, aligning with the United Nations Sustainable Development Goals (SDGs), particularly Quality Education (SDG 4) and Industry, Innovation, and Infrastructure (SDG 9). This aligns with the Institute of Mathematics for Industry (IMI), Kyushu University, which emphasizes uncovering new mathematical problems, developing innovative techniques, and enriching the field of mathematics through collaborative efforts with industry.

FMfI serves as a platform where real-world industrial challenges are presented to mathematicians, sparking the identification of novel mathematical problems. Issues such as optimizing semiconductor manufacturing, modelling fluid dynamics in porous media, and addressing systemic risks in financial markets expose gaps in existing mathematical theories and encourage the formulation of new problems. Industry-inspired challenges, such as those involving stochastic differential equations for pandemics or integrable differential geometry for design, are grounded in practical needs, prompting researchers to expand the boundaries of mathematical knowledge.

Key discussions highlighted advancements in mathematical modelling, stochastic modelling, decision analysis and analytics, and non-linear programming. Topics included the application of integrable differential geometry in industrial design, stochastic modelling for pandemic predictions and financial analysis, and the NURBS-Lagrange Finite Element Method for enhancing computational engineering. Presenters also explored the use of Bayesian methods and spatial statistics in addressing environmental challenges and fostering sustainable innovation.

The forum emphasized the integration of mathematics with real-world applications, such as optimizing semiconductor manufacturing, advancing agricultural water management, and improving petroleum engineering. A poster session featuring young researchers showcased innovations in mathematical optimisation and convective heat flux analysis, fostering talent development through awards and internship opportunities.

FMfI2024 demonstrated the critical role of mathematics in bridging academia, industry, and government, driving progress in industrial innovation and global competitiveness. Through cross-disciplinary collaboration, the forum advanced educational frameworks, sustainable practices, and cutting-edge research, reinforcing mathematics as a cornerstone for addressing complex societal and industrial challenges.

In general, participants agreed they benefited significantly from the program, with some suggesting that future conferences include more topics on the advancements in artificial intelligence and optimisation.

Introduction

Embedded within the comprehensive schedule of the International Symposium on Mathematics for Industry 2024 (ISMI2024), the **Forum of Mathematics for Industry 2024 (FMfI2024)** was a remarkable climax. This event convened 112 participants from academia, government, and industry, including attendees from Japan, Australia, Indonesia, Singapore, Germany, Thailand, Portugal, UK and Malaysia. Some joined the discussions online, reflecting the forum's inclusive approach. FMfI2024 provided a dynamic platform for addressing industrial challenges through applied mathematics, aligning with the United Nations Sustainable Development Goals (SDGs), particularly **Quality Education (SDG 4)** and **Industry, Innovation, and Infrastructure (SDG 9)**.

The theme, *"Mathematical Evolution Guiding Industrial Innovation Futures"*, highlighted the transformative role of mathematics in driving sustainable industrial innovation. FMfI 2024 facilitated cross-disciplinary collaboration, education, and research, emphasizing the integration of mathematical knowledge into real-world applications to support sustainable development.

The key presentations comprise five main agenda.

Advancing Industrial Innovation through Mathematics

Manuel Cruz highlighted the EU-MATHS-IN network's contributions to industrial mathematics, showcasing platforms like OpenDesk that connect mathematical theories with industrial needs, fostering innovation.

Kenji Kajiwara introduced advancements in integrable differential geometry, such as log-aesthetic curves and their extensions, with applications in design and manufacturing.

Addressing Global Challenges with Mathematical Applications

Xuerong Mao showcased stochastic modeling applications in pandemic prediction and financial risk analysis, leveraging stochastic differential equations and deep learning for parameter estimation.

Sharidan Shafie examined fluid dynamics in porous media, providing insights relevant to petroleum engineering and environmental management.

Ahmad Razin Zainal Abidin presented the NURBS-Lagrange Finite Element Method, combining precision geometry with computational efficiency for engineering solutions.

Philip Broadbridge exposed innovative mathematical solutions to a critical environmental and agricultural issue of efficient water management through application of Richard's equation.

Enhancing Industry-Academia Collaboration and Talent Development

Thomas Götz detailed the European Consortium for Mathematics in Industry (ECMI)'s educational programs, emphasizing the importance of training the next generation of industrial mathematicians.

Zainal Abdul Aziz introduced Malaysia's Quadruple Helix model, promoting academia-industry partnerships to advance innovation and research commercialization.

Mathematics in STEM and Educational Reform

Presentations during the roundtable discussion highlighted systemic challenges in Malaysia's mathematics education, advocating for reforms in curriculum design, teacher training, and STEM integration. Proposals included incorporating real-world applications into the curriculum to better prepare students for modern workforce demands, aligning with SDG 4 goals for quality education.

Specialized Applications in Emerging Fields

Dedy Prastyo integrated machine learning techniques like Quantile Regression Neural Networks and LASSO for financial econometrics, addressing systemic market risks.

Takashi Suzuki's work in computational biology explored cellular homeostasis, advancing understanding in cancer research.

Andri Ashfahani demonstrated AI-driven improvements in semiconductor manufacturing, highlighting defect detection and anomaly monitoring applications.

Poster Session and Student Engagement

FMfI2024 also featured a poster session showcasing innovative research by students, postdoctoral researchers, and early-career professionals. Sponsored by the Graduate Program of Mathematics for Innovations and Institute of Mathematics for Industry (IMI), Kyushu University, the poster competition provided awards and internship opportunities, fostering talent development and emphasizing the role of mathematics in achieving cutting-edge mathematical applications for sustainable innovation.

Achievements and Impact

The Forum of Mathematics for Industry 2024 exemplifies how mathematics can bridge academia, industry, government and community to address real-world challenges while advancing sustainable development goals. Its focus on fostering global partnerships, enhancing talent mobility, and leveraging innovative research highlights the enduring relevance of mathematics in driving progress and innovation across sectors. We recommend continued support and funding for such initiatives, ensuring that mathematics remains a cornerstone of education and industry, propelling sustainable development and global competitiveness.

FMfI2024 marked mathematics' critical role in addressing complex industrial and societal challenges. By fostering collaboration, advancing educational frameworks, and emphasizing sustainable practices, the forum made significant strides toward: i) Supporting **SDG 4: Quality Education**, through proposals for curriculum enhancement and teacher training reforms. ii) Achieving **SDG 9: Industry, Innovation, and Infrastructure**, by showcasing cutting-edge mathematical applications that drive industrial progress and sustainable innovation.

Acknowledgement
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The International Seminar on Mathematics in Industry 2024 (ISMI2024) is a conference fostering collaboration and synergy within the Quadruple Helix model, uniting academia, government agencies, industry, and the community. This event is dedicated to