Research Statement

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Background

Impactful research, to me, addresses practical problems where real-world challenges shape research questions, and scientific investigations yield evidence-based solutions. Drawing from my experience in IT consulting, I focus on data science, applied AI, and decision-making with applications in Education, Healthcare, and industries like Logistics and Retail. My work spans applied machine learning, learning analytics, and optimization techniques such as simulation and process mining. As a practice-track faculty member, I strive to balance rigorous research with practical applications, aiming to produce not only scientific publications but also tangible outcomes that benefit industry and education.

Research Areas

(1) Data Science, Applied Machine Learning and Decision-Making

Healthcare Operations and Citizen Well-Being

Improving service in healthcare is a meaningful challenge tied to people's well-being. During my PhD, in partnership with a healthcare institution, I developed algorithms addressing information processing, staffing, and queue management to enhance operations and patient care. My work focused on the Emergency Department (ED), including dynamic patient prioritization to optimize length-of-stay [1], a resource allocation algorithm for adjusting physician staffing based on arrival patterns [2], and a consolidated framework with a real-time simulator to manage patient flow and resources dynamically [3].

Over the past six years, my collaboration with hospitals has focused on optimizing processes, refining scheduling, and improving patient outcomes using data mining. One project developed a surgical duration prediction model addressing the research-to-practice gap. Unlike studies relying on post-surgical data, our model used feature engineering and multiple prediction methods to ensure feasibility for real-time scheduling across thirty disciplines in a public hospital [4].

My current research focuses on improving citizens' well-being and tackling societal health challenges through evidence-based analysis of behavioral patterns and lived experiences. This includes work on sustainable living such as using geolocational sensor data to assess wheelchair users' social participation [5] and applying COVID-19 risk stratification for targeted national interventions [6]. I also study young-adult mental wellness, using data-driven and Generative AI methods to identify risks and support early intervention. In parallel, I advance Person-Centred Care Planning and Healthy Ageing by leveraging Singapore's mandated interRAI assessments to

develop AI tools that support clinicians, nurses, and family caregivers in caring for elderly and frail individuals, ultimately improving population health and quality of life.

Urbanization and Optimization

In the context of urbanization, optimizing natural resource use and addressing congestion and pollution are critical. A key project, in collaboration with the Maritime Port Authority of Singapore (MPA), developed a framework to evaluate sustainability initiatives for Singapore's four port terminal types—container, bulk cargo, oil, and cruise. This work guided energy efficiency policies for Singapore's Next Generation Port (NGP) 2030 and received the Special Mention Award as the top-voted policy research at the Singapore Maritime Institute Research Showcase in April 2016 [7]. More recently, I worked on the Competitive Facility Location (CFL) problem, applying Adaptive Large Neighborhood Search (ALNS) with data enrichment techniques to optimize retail expansion in urban settings [8]. Some of my practice-oriented projects have led to commercial tools, including The Carbon Dashboard and The Carbon Calculator [9].

(2) Adaptive Learning and AI in Education

Personalized Learning with Dual-Perspective Feedback

I am deeply passionate about enhancing student learning through personalized interventions. My research focuses on developing a dual-perspective feedback system that integrates learner-centric reflection with instructor-oriented learning analytics to provide timely, personalized support. Earlier work introduced automated text-mining methods to assess understanding and surface doubts beyond traditional sentiment or question-detection approaches [10, 11]. Integrated into an adaptive learning platform, these models improved doubt identification and feedback effectiveness in pilot studies [12]. Extensions to platforms like StackOverflow further supported programming learners by predicting posts needing improved answers and introducing metrics to enhance knowledge sharing [13]. More recently, my team and I have advanced GenAI-supported tools for diagnosing learning needs and guiding targeted teaching intervention. Our work introduces *PromptTutor*, an LLM-based chatbot designed for flipped classrooms to provide personalized, immediate feedback during pre-class learning [14]. In a controlled crossover study with computer science undergraduates, *PromptTutor* showed statistically significant improvements in both quiz performance and motivation, demonstrating the capacity of LLM-driven systems to enhance learning outcomes and student engagement.

Advancing AI in Education

Recent research leverages Large Language Models (LLMs) to enhance educational tools through reflective learning, scaffolding strategies, and tailored feedback. I also examine the growing challenge of multi-modal assessment in computer science, including a study evaluating ChatGPT-4o on exercises involving diagrams, interface images, and analytical charts [15], which shows strong performance on lower-order tasks but limitations in higher-order reasoning. In parallel, I explore the use of LLMs for generating multiple-choice questions, identifying opportunities to improve item

discrimination and distractor quality. Together, these efforts aim to translate AI capabilities into practical teaching and assessment improvements. Beyond my institution, I contribute to the ASEAN community as an active member of the AUN-TEPL research group, supporting educators in adopting innovative AI-enhanced teaching tools and practices.

Going forward

I will sustain partnerships with healthcare institutions and government agencies to address healthcare and social well-being challenges through AI and data-driven approaches. My focus is on healthcare capacity management under uncertainty and operational flexibility in crises, aiming to develop resilient frameworks that optimize resource allocation and maintain care continuity in the community. For learning and education, I will continue to explore learning analytics and adaptive learning within and beyond computer science education, collaborating with like-minded researchers to innovate teaching tools and methodologies.

Selected Publications and Outputs

[1] Improving patient length-of-stay in emergency department through dynamic queue management, by Kar Way TAN, Hoong Chuin LAU, Francis Chun Yue LEE. Proceedings of the 2013 Winter Simulation Conference, Washington DC, Piscataway, NJ, 12/2013. (Published, Peer-Reviewed)
[2] Improving patient length-of-stay in emergency department through dynamic resource allocation policies, by Kar Way TAN, Wei Hao TAN, and Hoong Chuin LAU. Proceedings of IEEE International Conference on Automation Science and Engineering, Madison, Wisconsin, 08/2013. (Published, Peer-Reviewed)
[3] Improving patient flow in emergency department through dynamic priority queue, by Kar Way TAN, Chao WANG and Hoong Chuin LAU, Proceedings of IEEE International Conference on Automation Science and Engineering, Seoul, Korea, 08/2012. (Published, Peer-Reviewed)
[4] Data-Driven Surgical Duration Prediction Model for Surgery Scheduling: A Case-Study for a Practice-Feasible Model in a Public Hospital, by Kar Way TAN; Francis Ngoc Hoang Long NGUYEN, Boon Yew ANG, Jerald Tang Chow GAN, Sean Shao Wei LAM. Proceedings of IEEE Conference of Automation Science and Engineering, Vancouver, 08/2019. (Published, Peer-Reviewed) -- **Best Healthcare Paper Finalist.**
[5] Social Participation Performance of Wheelchair Users Using Clustering and Geolocational Sensor's Data, by Yukun YIN; Kar Way TAN. Proceedings of IEEE Conference of Automation Science and Engineering, Hong Kong, 08/2020. (Published, Peer-Reviewed)
[6] Combat COVID-19 at National Level Using Risk Stratification with Appropriate Intervention, by Xuan JIN, Kar Way TAN. Proceedings of IEEE Big Data, Italy, 12/2023. (Published, Peer-Reviewed)
[7] A Framework for Evaluating Energy Sustainability Efforts for Maritime Smart Port Operations, by Kar Way TAN, Michelle KAN, Pang Jin TAN and Stephan SCHABLINSKI, Proceedings of IEEE International Conference on ICT for Smart Society, 10/2018 (Published, Peer-Reviewed)
[8] A Data-Driven Approach for Automated Multi-Site Competitive Facility Location, by Ming Hui TAN, Kar Way TAN, Hoong Chuin LAU. Proceedings of IEEE Big Data, Washington, U.S., 12/2024. (Published, Peer-Reviewed)

[9] DHL GoGreen Carbon Dashboard and Carbon Calculator, DHL, website, https://www.dhl.com/global-en/home/our-divisions/global-forwarding/special-expertise/gogreen-solutions.html, last accessed on 24 December 2022.
[10] Do my students understand? Automated identification of doubts from informal reflections, by Siaw Ling LO, Kar Way TAN, Eng Lieh OUH. Proceedings of the 27th International Conference on Computers in Education. Taiwan: Asia-Pacific Society for Computers in Education, 2019. (Published, Peer-Reviewed) – **Overall Best Paper Finalist**
[11] Automated doubt identification from informal reflections through hybrid sentic patterns and machine learning approach; by Siaw Ling LO, Kar Way TAN, Eng Lieh OUH; Research and Practice in Technology Enhanced Learning (RPTEL), Vol 16(1), pp 1-24, 2021. (Published, Peer-Reviewed)
[12] AI-enabled adaptive learning using automated topic alignment and doubt detection, by Kar Way TAN, Siaw Ling LO, Eng Lieh OUH, Wei Leng NEO. Proceedings of the 2022 Annual Pacific Asia Conference on Information Systems (PACIS), 07/2022. (Published, Peer-Reviewed)
[13] Machine-Learning Approach to Automated Doubt Identification on Stack Overflow Comments to Guide Programming Learners, by Tian Hao Chen, Eng Lieh OUH, Kar Way TAN, Siaw Ling LO. Proceedings of the 2023 Annual Pacific Asia Conference on Information Systems (PACIS), 07/2023. (Published, Peer-Reviewed)
[14] PromptTutor: Effects of an LLM-based chatbot on learning outcomes and motivation in flipped classrooms, by Yuhao ZHANG; EngLieh OUH; Adam HO; Siaw Ling LO; Kar Way TAN; Feng LIN. Proceedings of the 30th ACM Conference on Innovation and Technology in Computer Science Education ITiCSE 2025, 07/2025. (Published, Peer-Reviewed)
[15] Evaluating ChatGPT to answer multi-modal exercises in computer science education, by Eng Lieh OUH; Kar Way TAN; Siaw Ling LO; Benjamin K.S GAN. Proceedings of the 30th ACM Conference on Innovation and Technology in Computer Science Education ITiCSE 2025, 07/2025. (Published, Peer-Reviewed)