

**Research Proposal for International MSc thesis
(In collaboration with The University of Sheffield)**

Hydrogen Safety in Transportation – Focusing on Hydrogen-Fueled Ships

Project Description:

With the urgent global push towards decarbonizing the transport sector, hydrogen is emerging as a promising clean fuel, especially for hard-to-decarbonize modes of transport, such as shipping. Maritime transport contributes significantly to global greenhouse gas emissions, and hydrogen presents a viable zero-emission alternative to fossil fuels. Hydrogen-fuelled ships, powered by hydrogen combustion engines or fuel cells, are being actively explored and piloted. However, hydrogen is a highly flammable gas with unique safety risks, especially in confined marine environments. The storage, transfer, and use of hydrogen on board vessels introduce new safety challenges that must be addressed before large-scale deployment. This project focuses on identifying, analysing, and managing the safety risks of using hydrogen as a marine fuel, aiming to develop a structured framework for improving hydrogen safety in maritime transportation.

Research Aim and Objectives

- To investigate the safety challenges and propose risk-informed safety strategies for the use of hydrogen in maritime transport, focusing on hydrogen-fuelled ship systems.
- To review current and emerging hydrogen technologies used in maritime transport.
- To identify and classify key hazards related to hydrogen production, storage, transfer, and usage onboard ships.
- To assess the risks associated with hydrogen systems in shipboard environments using suitable safety assessment tools.
- To analyse international safety standards, guidelines, and regulatory frameworks related to hydrogen and maritime applications.
- To propose a set of safety design principles and operational recommendations for hydrogen-powered vessels.

Skills Required:

Motivation and skills for data collection, analysis, and modelling. Ability to work collaboratively and communicate effectively. Critical thinking and problem-solving skills.

Learning Outcomes for Students:

By completing this project, students will gain:

- **Technical Knowledge of Hydrogen Systems:** Understanding of hydrogen propulsion technologies and marine fuel systems.
- **Safety and Risk Assessment Skills:** Proficiency in hazard identification and risk analysis tailored to shipboard environments.
- **Regulatory Awareness:** Familiarity with maritime safety codes and hydrogen standards.
- **Systems Thinking and Problem Solving:** Ability to analyse complex systems and propose practical safety solutions.
- **Research and Communication Skills:** Experience in conducting independent research and presenting technical findings clearly.
- **Industry-Relevant Experience:** Insight into a real-world challenge at the intersection of clean energy and transport.

Extra Information or Reading List:

Van Hoecke, Laurens, et al. "Challenges in the use of hydrogen for maritime applications." *Energy & Environmental Science* 14.2 (2021): 815-843.

Depken, Jorgen, et al. "Safety considerations of hydrogen application in shipping in comparison to LNG." *Energies* 15.9 (2022): 3250.

Hoseyni, Seyed Mojtaba, Mohamed Osman Mesbah Mostafa, and Joan Cordiner. "Mitigating risks in hydrogen-powered transportation: A comprehensive risk assessment for hydrogen refuelling stations, vehicles, and garages." *International Journal of Hydrogen Energy* 91 (2024): 1025-1044.

Najjar, Y. S. (2013). Hydrogen safety: The road toward green technology. *International Journal of Hydrogen Energy*, 38(25), 10716-10728.

Wei, Ruichao, Jiamei Lan, Liping Lian, Shenshi Huang, Chen Zhao, Zhurong Dong, and Jingwen Weng. "A bibliometric study on research trends in hydrogen safety." *Process Safety and Environmental Protection* 159 (2022): 1064-1081.

Name of the research directors:

Prof Enrico Zio (PoliMi) and Dr Seyed Mojtaba Hoseyni (University of Sheffield)

For further information, please contact Prof. Enrico Zio, enrico.zio@polimi.it, 02 2399 6340