



PhD in Information Technology and Electrical Engineering
Università degli Studi di Napoli Federico II

PhD Student: Luisa Montella

Cycle: XXXIX

Training and Research Activities Report

Academic year: 2024-25 - PhD Year: Second

Tutor: prof. Stefania Santini

Co-Tutor: prof. Teresa Murino (DICMaPI)

Eng. Dario Bocchetti (Grimaldi Euromed S.p.A.)

Date: October 31, 2025

Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle:

Author:

1. Information:

- **PhD student:** Luisa Montella **PhD Cycle:** 39th
- **DR number:** DR997219
- **Date of birth:** 24/07/1998
- **Master Science degree:** Management Engineering
University: University of Naples “Federico II”
- **Scholarship type:** PNRR - DM 117, funding company: Grimaldi Euromed S.p.A.
- **Tutor:** prof. Stefania Santini
- **Co-tutor:** prof. Teresa Murino (DICMaPI), Eng. Dario Bocchetti (Grimaldi Euromed S.p.A.)
- **Nr. of months in company (Grimaldi Euromed S.p.A.):** 15
Nr. of months abroad: 6

2. Study and training activities:

Activity	Type ¹	Hours	Credits	Dates	Organizer	Certificate ²
“The power of inhibition for collective decision making in minimalistic robot swarms”	Seminar	1	0.2	14/11/2024	Prof. Giacomo Ascione (SSM)	Y
“Phase transitions in the nucleus of cells”	Seminar	1	0.2	21/11/2024	Prof. Giacomo Ascione (SSM)	Y
“AI and Enabling Technologies for Social Robots”	Seminar	1.5	0.3	03/12/2024	Prof. Franco Cutugno	Y
“Strutture basate su regole e strutture basate su Approssimazioni”	Seminar	1.5	0.3	10/12/2024	Prof. Franco Cutugno	Y
“Lunar Laser Retroreflectors for ESA-ASI’s Moonlight, Farside & South Pole”	Seminar	1	0.2	16/01/2025	Prof. Giacomo Ascione (SSM)	Y
“II Freshmen PhD & Professionals Cruise School 2025 (Marseille – Barcelona – Palma de Mallorca – Palermo – Rome)”	Doctoral School	19	4	18/01/2025 – 25/01/2025	University of Genoa	Y
“Bridging Physics to Biomedical Sciences”	Seminar	1	0.2	30/01/2025	Prof. Giacomo	Y

Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle:

Author:

					Ascione (SSM)	
“Optimisation-based Control of Flexible Resources in Sustainable Energy Networks”	Seminar	1	0.2	05/02/2025	Prof. Luigi Glielmo	Y
“Dynamic Risk Assessment in Industrial Applications: Leveraging Bayesian Inference for Enhanced Decision-Making”	Seminar	1	0.2	04/03/2025	Prof. Francesco Vitale	Y
“Numerical bifurcation analysis for delay equations”	Seminar	1	0.2	07/03/2025	Prof. Gabor Orosz (TDS webinar)	Y
“5G & DIGITAL TRANSFORMATION: A VIEW FROM AN UNCONVENTIONAL PERSPECTIVE – Second edition”	Seminar	4	0.8	14/03/2025	Prof. Antonia Tulino	Y
“Robot Autonomy among Decision-Making Agents”	Seminar	1	0.2	15/04/2025	Prof. Fabio Ruggiero	Y
“Sistemi elettrici di bordo”	Course	48	6	26/06/2025	Bianca Caiazzo, PhD	Y
“Journal Search and Publishing Strategies”	Seminar	1	0.2	20/08/2025	Dr. Clark Holdsworth , LetPub Learning Nexus	Y
“MILP Formulation for Piecewise Linear Fitting: A Rigorous Alternative to Neural Networks for Multidimensional Data”	Seminar	1	0.2	20/08/2025	Dr. Quentin Ploussard, Argonne National Laboratory	Y
“Control of multi-agent systems with time delays: theory and applications”	Seminar	1	0.2	05/09/2025	Prof. Stefania Santini, TDS webinar	Y
“Estimations of Unimodular Signal	Seminar	1	0.2	02/10/2025	Prof. Massimo Rosamilia	Y

Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle:

Author:

Waveform and Uncertain Receive Signal Steering Vector for Robust Optimal Receive Beamforming Design”						
“IEEE Authorship and Open Access Symposium: Tips and Best Practices to Get Published from IEEE Editors”	Seminar	1.5	0.3	15/10/2025	Dr. Anuradha Annaswamy (Massachusetts Institute of Technology - MIT, USA)	Y
“Optimization in Transportation and Logistics”	Seminar	1	0.2	16/10/2025	Prof. Maruzio Boccia, Prof. Claudio Sterle, Prof. Adriano Masone	Y
“Local Explainability in Machine Learning: A collective framework”	Seminar	1	0.2	16/10/2025	Prof. Maruzio Boccia, Prof. Claudio Sterle, Prof. Adriano Masone	Y
“Exact and ML-guided Matheuristic approaches for a Truck-and-Drone delivery problem”	Seminar	1	0.2	17/10/2025	Prof. Maruzio Boccia, Prof. Claudio Sterle, Prof. Adriano Masone	Y
“Guardians or Threats? AI at the Frontlines of Cybersecurity”	Seminar	4	0.8	17/10/2025	Prof. Antonia Tulino	Y
“Boosting Your Citations: Maximizing the Impact of Your Publications”	Seminar	1	0.2	21/10/2025	LetPub	Y

1) Courses, Seminar, Doctoral School, Research, Tutorship

Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle:

Author:

2) Choose: Y or N

2.1. Study and training activities - credits earned

	Courses	Seminars	Research	Tutorship	Total
Bimonth 1	0	1	9	0	10
Bimonth 2	4	0.6	5.4	0	10
Bimonth 3	0	1.4	8.6	0	10
Bimonth 4	6	0	4	0	10
Bimonth 5	0	0.4	9.6	0	10
Bimonth 6	0	2.3	7.7	0	10
Total	10	5.7	44.3	0	60
Expected	30 - 70	10 - 30	80 - 140	0 - 4.8	

3. Research activity:

The maritime transport sector plays a central role in global trade but remains one of the largest contributors to greenhouse gas emissions, accounting for about 3% of global CO₂ output. In this context, the decarbonization of maritime operations has become a strategic priority, reinforced by international regulations such as the Carbon Intensity Indicator (CII) introduced by the International Maritime Organization (IMO). To comply with these standards, shipping companies are adopting energy-efficiency measures such as hybrid propulsion systems, battery storage, and cold ironing technologies that allow ships to use shore-side electricity while berthed [1]. However, the real effectiveness of these measures strongly depends on how ships are operated and how energy flows are managed on board, which are still difficult to evaluate systematically. This creates the need for data-driven frameworks capable of transforming operational data into meaningful indicators for energy performance assessment and sustainable fleet management.

The ongoing digitalization of the maritime sector has enabled the continuous collection of vast amounts of operational data from shipboard systems such as sensors, Voyage Data Recorders, and Energy Management Systems. However, the maritime industry still faces significant challenges in transforming such data into useful knowledge for decision-making and sustainability evaluation. As shown in [2], digitalization in maritime logistics remains fragmented, with limited theoretical and empirical frameworks; [3] identified four major clusters in maritime big data research, including digital transformation, energy efficiency, and predictive analytics; and [4] emphasized that the adoption of Industry 4.0 technologies in ports and terminals—such as IoT, cloud computing, and big data analytics—remains uneven and in early stages for many maritime applications.

Similarly, [5] and [6] highlight that although digitalization and big data are reshaping maritime logistics, the sector still lacks comprehensive tools and architectures for automated data collection, visualization, and analysis. The latter study notably proposed a distributed system for trend visualization and data extraction from multiple sources, demonstrating the importance of visual analytics in understanding complex industrial systems. Collectively, these works emphasize both the need and opportunity for data-driven innovation in maritime transport, where operational datasets remain underexploited despite their potential to drive efficiency and sustainability improvements.

Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle:

Author:

This situation parallels developments in other energy-intensive sectors, such as manufacturing and building management, where big data analytics and machine learning have already been successfully adopted to quantify energy efficiency and predict retrofitting outcomes. For example, [7] proposed a big-data-driven analytical framework for energy-intensive manufacturing industries, while [8] demonstrated the use of deterministic and data-driven methods to quantify energy savings and evaluate retrofitting scenarios in buildings.

Building on these insights, my PhD research focuses on developing a data-driven framework for energy performance analysis and predictive assessment in maritime transport, transferring and adapting methodological approaches from these domains to the specific challenges of ship operational data—characterized by heterogeneity, intermittency, and strong operational variability.

During the current year, I developed R-based scripts to automatically retrieve, clean, and reorganize ship operational data obtained from the industrial partner's servers via API calls. These scripts generate structured datasets containing accurate measures of energy and power use, categorized by operational modes. This process establishes a solid foundation for data-driven analyses of ship energy performance and for identifying the impact of different operational configurations on fuel consumption and emissions.

The methodological direction of this research aligns with recent contributions in the literature that explore the integration of multi-criteria decision-making (MCDM), big data, and artificial intelligence for energy performance evaluation. For instance, [9] and [10] studies have demonstrated how data-driven and decision-support techniques can be applied to analyze industrial energy systems and maritime operations. These references collectively support the relevance and scientific soundness of the approach adopted in this PhD work.

Overall, the activities carried out during this year established the groundwork for the systematic use of ship operational data in energy performance analysis, situating the research within the broader scientific discourse on digitalization and big data analytics for sustainable maritime transport.

References:

- [1] Bouman, E. A., Lindstad, E., Rialland, A. I., & Strømman, A. H. (2017). *State-of-the-art technologies, measures, and potential for reducing GHG emissions from shipping – A review*. Transportation Research Part D: Transport and Environment, 52, 408–421. <https://doi.org/10.1016/j.trd.2017.03.022>
- [2] Fruth, M., & Teuteberg, F. (2017). *Digitization in maritime logistics—What is there and what is missing?* Cogent Business & Management, 4(1), 1411066. <https://doi.org/10.1080/23311975.2017.1411066>
- [3] Munim, Z. H., Dushenko, M., Jimenez, V. J., Shakil, M. H., & Imset, M. (2020). *Big data and artificial intelligence in the maritime industry: a bibliometric review and future research directions*. Maritime Policy & Management, 47(5), 577–597. <https://doi.org/10.1080/03088839.2020.1788731>

Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle:

Author:

- [4] De la Peña Zarzuelo, I., Freire Soeane, M. J., & López Bermúdez, B. (2020). *Industry 4.0 in the port and maritime industry: A literature review*. Journal of Industrial Information Integration, 20, Article 100173. <https://doi.org/10.1016/j.jii.2020.100173>
- [5] An, J. (2024). *Maritime logistics and digital transformation with big data: review and research trend*. Maritime Business Review, 9(3), 229-242. <https://doi.org/10.1108/MABR-10-2023-0069>
- [6] Antonov, E. V., Artamonov, A. A., Rudik, A. V., & Malugin, M. I. (2022). *Trend Visualization of Academic Field: Proposed Method and Big Data Review*. Scientific Visualization, 14(2), 62-76. <https://doi.org/10.26583/sv.14.2.06>
- [7] Zhang, Y., Ma, S., Yang, H., Lv, J., & Liu, Y. (2018). A big data driven analytical framework for energy-intensive manufacturing industries. Journal of Cleaner Production, 197, 57-72. <https://doi.org/10.1016/j.jclepro.2018.06.170>
- [8] Grillone, B., Lomas, K. J., & Ratti, S. (2020). A review of deterministic and data-driven methods to quantify energy efficiency savings and to predict retrofitting scenarios in buildings. Renewable and Sustainable Energy Reviews, 131, Article 110027. <https://doi.org/10.1016/j.rser.2020.110027>
- [9] Franzese G., Montella L., Murino T., Somma A., Strazzullo M., *A Data-Driven Framework for the Evaluation of Autonomous and Traditional Berthing Maneuvers in Maritime Operations*, in New Trends in Intelligent Software Methodologies, Tools and Techniques, vol. 250, pp. 529–540, IOS Press, 2025. doi: 10.3233/FAIA250529.
- [10] Montella, L., Liu, X., Monaco, R., Murino, T., & Nielsen, P. S. (2025). *An integrated multi-criteria decision making framework for industrial excess heat recovery and utilization*. Energy, 318, Article 134721. <https://doi.org/10.1016/j.energy.2025.134721>

4. Research products:

- [1] Montella L., Ayokunle O. V., Salvi F., “Healthcare System Approach for Implementing Risk Management Models Oriented to Patient Safety”, *Lecture Notes in Bioengineering*, pp. 411 – 419, 2025. DOI: 10.1007/978-3-031-82923-9_38
(Published – Indexed in Scopus)
- [2] Montella L., Liu X., Monaco R., Murino T., Sieverts Nielsen P., “An integrated multi-criteria decision making framework for industrial excess heat recovery and utilization”, *Energy*, Volume 318, 2025, 134721, ISSN 0360-5442, <https://doi.org/10.1016/j.energy.2025.134721>
(Published – Indexed in Scopus and Web of Science)
- [3] Franzese G., Montella L., Murino T., Somma A., Strazzullo M., “A Data-Driven Framework for the Evaluation of Autonomous and Traditional Berthing Maneuvers in Maritime Operations”, in *New Trends in Intelligent Software Methodologies, Tools and Techniques*, vol. 250, pp. 529–540, IOS Press, 2025. doi: 10.3233/FAIA250529.
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Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle:

Author:

Awards:

Best presentation award during the PhD project presentation session on 20th January 2025 of the “II Freshmen PhD & Professionals Cruise School 2025” with the PhD project “Toward a Sustainable Maritime Sector: An Innovative Framework for Energy Optimization and Environmental Performance Evaluation of Shipboard Microgrids”.

5. Conferences and seminars attended

[1] SOMET 2025: The 24th International Conference on Intelligent Software Methodologies, Tools, and Techniques

Kitakyushu, Japan | September 23-26, 2025

Paper presented: Franzese G., Montella L., Murino T., Somma A., Strazzullo M., “A Data-Driven Framework for the Evaluation of Autonomous and Traditional Berthing Maneuvers in Maritime Operations”, in *New Trends in Intelligent Software Methodologies, Tools and Techniques*, vol. 250, pp. 529–540, IOS Press, 2025. doi: 10.3233/FAIA250529.

[2] II PhD Freshmen Cruise School 2025, “AI for the Sustainable Blue Economy: Industry, Healthcare, and Government”

Marseille – Barcelona – Palma de Mallorca – Palermo – Rome, January 19th – 24th 2025

PhD project presented: “Toward a Sustainable Maritime Sector: An Innovative Framework for Energy Optimization and Environmental Performance Evaluation of Shipboard Microgrids”.

6. Periods abroad and/or in international research institutions

During the current year, research activities were mainly conducted in collaboration with the industrial partner (Grimaldi Euromed S.p.A.), within the framework of the co-funded PhD fellowship “Sustainable Transition toward Greener and Cleaner Maritime Transport.” The collaboration provided continuous access to real operational data from the company’s fleet and technical supervision from the R&D department.

Within this collaboration, several R codes were developed for the automated retrieval, cleaning, and reorganization of ship operational data from company servers. These codes form the computational basis for subsequent analysis and predictive modeling phases and represent an essential technical output of the current year’s work.

At present, no research period abroad has yet been undertaken.

According to the PhD fellowship agreement, a research stay abroad of 6 months is foreseen, as well as a period of industrial activity lasting 15 months.

So far, 12 months have been spent within the company between November 2023 and October 2025, focused on data collection, preprocessing, and methodological development using real ship data.

A research period abroad is planned during the third PhD year to strengthen international collaboration and to explore complementary expertise in maritime data analytics and sustainable energy systems. The stay is expected to focus on data-driven approaches to maritime energy performance and sustainability assessment.

Total months abroad in the current year: 0

Total months in company: 12

7. Tutorship

Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle:

Author:

8. Plan for year three

The third year of the PhD will aim to consolidate and extend the research activities already undertaken. Building on the structured datasets and analytical framework developed so far, the focus will shift toward predictive modeling and data-driven analysis of ship energy performance, possibly using machine learning algorithms to forecast fuel consumption and energy demand under different operational conditions.

Efforts will also be directed toward graphical representation and visualization of results, to support the interpretability and communication of data insights to both academic and industrial audiences. The specific methods and tools will be defined progressively based on the results obtained during the initial implementation and testing phases.

In parallel, the collaboration with the industrial partner will continue, expanding the analysis to additional vessels, operating conditions, and key subsystems to validate the methodology and evaluate its scalability. Participation in specialized courses and seminars related to data analytics, energy systems, and sustainable transport is also foreseen to enhance the research and methodological background in view of the completion of the PhD program.