PhD in INGEGNERIA GESTIONALE / MANAGEMENT ENGINEERING - 41st cycle

THEMATIC Research Field: BROWNFIELD OR GREENFIELD FOR PHA CAPACITY EXPANSION: A REAL OPTIONS AND STAGE-GATE APPROACH WITH LIFE CYCLE ASSESSMENT

Monthly net income of PhDscholarship (max 36 months)
1500.0 In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	The global transition toward a circular and low-carbon economy has brought to the forefront the urgent need to develop sustainable materials capable of replacing fossil-based plastics. Among the various emerging solutions, polyhydroxyalkanoates (PHA) have gained increasing attention as biodegradable and bio-based polymers that can significantly reduce the environmental footprint of the plastics industry. Yet, despite their promising characteristics, PHA production technologies still face significant challenges in terms of economic viability, process scalability, and market readiness. This tension between environmental ambition and industrial feasibility situates the field within one of today’s Grand Challenges—that of reconciling industrial growth with environmental sustainability. Within this context, the company supporting the present research has already developed and validated a PHA production technology at pilot scale. Its current strategic need is to explore the technical scalability of this process, identifying the most effective configuration for expanding production capacity while ensuring environmental and economic performance. This involves evaluating alternative project configurations—such as brownfield versus greenfield investments—and determining how to manage uncertainty regarding costs, demand, and regulatory developments.

	From a research standpoint, this industrial endeavor provides a unique opportunity to frame the expansion of PHA production as a sustainability transition project—that is, as a project-based response to a Grand Challenge. The study aims to investigate how project management principles, decision-making frameworks, and governance mechanisms can enable organizations to manage high uncertainty while pursuing sustainability-oriented innovation. Specifically, it seeks to integrate methods such as the Real Options and Stage-Gate approaches with Life Cycle Assessment to support flexible, responsible, and learning-oriented decision-making throughout the project's lifecycle. The case is positioned within the broader debate on how projects contribute to addressing grand societal challenges, as the research aims to advance both theoretical and practical understanding of how industrial projects can serve as vehicles for sustainable transformation—balancing technological scalability, environmental legitimacy, and long-term value creation.
Methods and techniques that will be developed and used to carry out the research	The research adopts a mixed-method approach that combines conceptual development, in-depth case study analysis, and empirical validation through survey research. This research design allows for both theoretical advancement and practical insight into how industrial projects can address grand societal challenges such as the transition toward sustainable materials. The first phase will consist of a systematic literature review aimed at identifying how current project management theories—particularly those concerning project governance, flexibility, and sustainability transitions—conceptualize industrial responses to environmental Grand Challenges. This review will help position the research within the broader academic debate and inform the development of an initial analytical framework that integrates Real Options, Stage-Gate, and Life Cycle Assessment (LCA) approaches. The second phase will involve a longitudinal case study conducted in close collaboration with the industrial partner

	that has developed a pilot-scale PHA production technology. The case will provide empirical grounding for analyzing how decision-makers navigate uncertainty, evaluate alternative expansion scenarios (e.g., brownfield versus greenfield), and integrate environmental and economic considerations. Through qualitative interviews, document analysis, and process mapping. This phase will explore how the Real Options–Stage-Gate logic can guide investment decisions while embedding sustainability assessments such as LCA. Building on the insights from the case study, the third phase will develop a survey instrument to collect data from a broader sample of organizations engaged in sustainability-oriented technology projects. The survey will test and refine the conceptual model derived from the earlier stages, enabling the identification of key governance mechanisms, decision-making practices, and organizational capabilities that support flexibility and learning under uncertainty.
Educational objectives	This doctoral research aims to develop a solid interdisciplinary competence that bridges sustainability-oriented innovation, industrial project management, and decision analysis under uncertainty. Through the investigation of PHA-based bioplastic production as a response to global environmental challenges, the candidate will acquire both theoretical and practical expertise in designing and governing industrial projects that contribute to the green transition. From an educational standpoint, the project is designed to strengthen the candidate's ability to integrate strategic, technical, and managerial perspectives. The study of decision-making frameworks such as Real Options and Stage-Gate will build advanced analytical capabilities for evaluating alternative investment pathways. This integration will foster the ability to manage trade-offs between economic feasibility, environmental performance, and long-term value creation. The use of a systematic literature review, an in-depth industrial case study, and a quantitative survey will enable the candidate to master a wide range of research methodologies—qualitative, quantitative, and mixed-

	method—thus ensuring methodological rigor and versatility. The direct collaboration with the industrial partner will further enhance learning-by-doing competences, including data collection in real industrial contexts, stakeholder engagement, and the translation of theoretical models into managerial tools and decision-support systems. Moreover, the research will cultivate critical reflection and responsible innovation skills, encouraging the candidate to position industrial projects within the broader agenda of the Grand Challenges.
Job opportunities	The doctoral project will equip the candidate with a professional profile positioned at the intersection of project management, sustainability transitions, and industrial innovation. This combination of competences opens multiple career paths across academia, industry, and public policy. Within the industrial domain, the expertise developed in this research—covering decision analysis under uncertainty and governance of green technology projects—will be highly valuable for organizations investing in bio-based and circular economy solutions. The candidate will be qualified to assume roles such as Project Manager, Sustainability Innovation Manager, or R&D Portfolio Analyst in sectors including bioplastics, chemical and process industries, energy transition, and advanced manufacturing. The ability to apply frameworks such as Real Options to guide strategic investment decisions will represent a key differentiator in companies navigating the challenges of industrial decarbonization and technological scaling. In the academic and research sphere, the project will prepare the candidate for a career as a researcher or lecturer in universities and research centers focused on sustainability-oriented project management, innovation governance, and industrial ecology. The methodological combination of literature review, case study, and survey research will provide a solid foundation for future scholarly work, enabling contributions to leading journals such as the International Journal of Project Management, Project Leadership and Society, or Journal of Cleaner Production.

Composition of the research group	1 Full Professors 0 Associated Professors 1 Assistant Professors 1 PhD Students
Name of the research directors	Mauro Mancini

Contacts
mauro.mancini@polimi.it

Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents	--

Scholarship Increase for a period abroad	
Amount monthly	750.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

The doctoral candidate will be fully integrated into the research and educational environment of the Department of Management, Economics and Industrial Engineering at Politecnico di Milano. A dedicated desk will be made available within the research area of project management. The candidate will also have access to computing resources.
Opportunities for teaching assistantship may be offered during the course of the PhD, depending on the candidate's interests and the research group's teaching needs.

For the overall development of their capabilities, PhD candidates will work on sinergical projects to favour empirical data collection and network development for their career. Projects will give candidates the opportunity to work in groups (peers and other senior professors).

If coherent with the development of their doctoral program, the PhD candidate will have the opportunity to be involved in: teaching activities, tutoring to master students, tutoring to PhD candidates for administrative processes.

The development of the PhD project requires a compulsory period to be spent in the company (sometimes in a different city) to better understand the company strategy and processes.

The interaction with key stakeholders requires a fluent knowledge of the Italian language.

Funding for educational activities: 6.100,00 Euros for three years.