

# Assignment 1:Project proposal /Innovation & Research

25 November 2025

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Assignment 1/Innovation & Research

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## Task 1

Innovation shapes the world by transforming how humans live, work, and interact. Technological advancements, from the printing press to artificial intelligence, increase productivity, expand knowledge, and connect people globally. Economically, innovation drives new industries, creates jobs, and boosts competitiveness. Socially, it improves healthcare, education, and communication, enhancing quality of life. Environmentally, innovations like renewable energy, AI-driven waste management, and sustainable materials address global challenges and reduce ecological impact. Culturally, innovation reshapes learning, creativity, and knowledge sharing. Overall, innovation turns challenges into opportunities, propelling human progress, fostering sustainability, and continually redefining the future of societies worldwide.[1]

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## Ideation

## Quick Notes Page 2

The history of AI-driven plastic degradation system, A major leap occurred in 2022, researchers used machine-learning (ML) algorithms to design an enhanced PETase enzyme that surpasses previous versions in both speed and robustness.

In this work, a neural network trained on thousands of protein sequences predicted amino-acid substitutions likely to improve enzyme stability and catalytic activity. Applying these suggestions, researchers created an enzyme (often dubbed FAST-PETase) that could depolymerize real-world PET containers twice as fast and at lower temperatures compared to previous engineered PETase variants.[2]

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# Task 2: AI-driven plastic degradation system

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## Aim:

The aim of this project is to develop an AI-driven plastic degradation system that can automatically identify, sort, and accelerate the breakdown of plastic waste using artificial intelligence, sensor technologies, and biological or chemical degradation methods. This system aims to provide a sustainable solution to reduce plastic pollution while improving recycling efficiency.

## Objectives:

The objective of this project is to design and implement an AI-driven plastic degradation system that accelerates the breakdown of common polymers through optimized biological and chemical pathways. By integrating machine-learning models with real-time sensor data, the system will identify plastic types, predict ideal degradation conditions, and autonomously regulate environmental variables to maximize efficiency. The solution aims to reduce plastic persistence in landfills and natural ecosystems, lower treatment costs, and provide scalable technology adaptable to various waste-management infrastructures. Ultimately, the project seeks to create a smart, sustainable platform that transforms plastic waste into safer, reusable by-products.

1. **Develop a machine learning model** capable of accurately identifying and classifying different types of plastics (e.g., PET, HDPE, PVC) using computer vision technologies.
2. **Integrate biodegradation or enzymatic degradation methods** with AI to optimize the breakdown of plastics under controlled environmental conditions.
3. **Implement IoT-enabled sensors** to monitor environmental parameters such as temperature, pH, and humidity in real-time to enhance degradation efficiency.
4. **Design predictive AI algorithms** to dynamically adjust degradation parameters and optimize the overall process for different plastic types.
5. **Evaluate the environmental and operational impact** of the AI-driven system compared to conventional recycling techniques, focusing on efficiency, cost, and sustainability.

## Research Philosophy

The appropriate research philosophy for this project is pragmatism. Pragmatism focuses on practical solutions and real-world outcomes by combining different research approaches, making it ideal for technology-based projects that require experimentation and application (Saunders, Lewis, & Thornhill, 2019). [5]

In the context of the AI-driven plastic degradation system, pragmatism allows the integration of quantitative research, such as measuring degradation efficiency, AI

model accuracy, and operational parameters, with qualitative research, such as assessing environmental impact, feasibility, and potential social benefits. By adopting a pragmatic philosophy, the project can iteratively test and optimize AI models and biodegradation techniques, ensuring the system is both technically effective and practically implementable in real-world waste management scenarios.[6]

### **Research Tools and Search Strategies**

Researching AI-driven plastic degradation requires access to academic, technical, and industry-focused sources. Appropriate search tools and databases include:

- **Google Scholar:** Provides a broad collection of scholarly articles, conference papers, and patents related to AI, plastic recycling, and environmental sustainability.
- **ScienceDirect:** Offers peer-reviewed journal articles focused on biotechnology, enzymatic degradation, and AI applications in waste management.
- **IEEE Xplore:** Specialized in computer science and engineering, useful for research on machine learning algorithms, computer vision, and IoT integration.
- **PubMed:** For research on microbial and enzymatic plastic degradation techniques, including the use of PETase and other enzymes.
- **SpringerLink:** Contains multidisciplinary research on AI, environmental engineering, and sustainable technologies.[7][8]

### **Search Strategies:**

1. **Keyword Selection:** Use specific, targeted keywords such as *“AI plastic degradation”*, *“machine learning waste sorting”*, *“enzymatic plastic breakdown”*, *“IoT waste monitoring”*, and *“biodegradable plastics optimization”*.
2. **Boolean Operators:** Combine keywords with AND, OR, NOT for precision (e.g., *“AI AND plastic degradation AND enzyme”*).
3. **Filters and Limits:** Restrict searches to recent publications (2018–2025) and peer-reviewed journals to ensure relevance and credibility.
4. **Citation Chaining:** Review references from relevant articles to identify foundational research and additional sources.
5. **Database-Specific Tools:** Use advanced search functions, topic tags, and abstract previews in IEEE Xplore and ScienceDirect to refine results.

These strategies enable a thorough understanding of current technologies, challenges, and innovations in AI-driven plastic degradation. They form the basis for designing a system that is technologically feasible, environmentally sustainable, and socially impactful.

# Task 3 : Research Strategies

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## **Research strategies**

### **Enhance Validity, Reliability, Generalisability, and Ethical Considerations in an AI-Driven Plastic Degradation System,**

Enhancing validity, reliability, generalisability, and ethical integrity is essential for producing trustworthy research, particularly in studies involving emerging technologies such as AI-driven plastic degradation systems. Validity can be improved through triangulation, combining qualitative interviews, system data, and observational records to confirm findings. Clear operational definitions for key concepts such as “degradation efficiency” or “AI accuracy” also strengthen construct validity (Creswell & Creswell, 2018). Reliability can be enhanced by using standardised data collection tools, such as structured interview guides and consistent experimental protocols. Maintaining an audit trail documenting decisions, coding processes, and procedures helps ensure that results can be replicated.[2]

To improve generalisability, sampling should include diverse organisational contexts to ensure that insights extend beyond a single environment. Providing thick descriptions of the technological setting and organisational processes further supports transferability (Lincoln & Guba, 1985). Ethical considerations must include informed consent, confidentiality, and secure handling of sensitive operational data, especially when AI-generated performance metrics may be proprietary. Ethical risks such as algorithmic bias or environmental misrepresentation should be acknowledged and mitigated through transparent reporting and adherence to research governance standards.

Collectively, these strategies ensure rigour and integrity throughout the research process.

### **Research Strategies and Pilot Data Collection Method**

For this project a mixed-methods research strategy is which is working by combining quantitative experiments with qualitative stakeholder insights.

Quantitative data will be collected through laboratory-based experiments that monitor degradation rates of various plastics (e.g., PET, HDPE) under controlled conditions. Key metrics include AI prediction accuracy, enzyme efficiency, and environmental parameters such as temperature and PH. This approach enables precise measurement of system performance and supports data-driven conclusions.

Qualitative data will be gathered through semi-structured interviews with operators, AI engineers, and sustainability officers to understand practical challenges, adoption barriers, and perceptions of AI integration in waste processing. Observation of workflows and document analysis of organizational procedures will further contextualize findings.

A **pilot data collection method** will be implemented on a small-scale experiment will involve two types of plastics and three to five expert participants. Degradation outcomes and AI performance metrics will be recorded, while interviews will test question clarity and relevance. Feedback from this pilot will inform modifications to

lab protocols and interview guides.

## Quantitative and Qualitative Analysis

Both quantitative and qualitative analyses are essential to evaluate performance and understand contextual factors. Quantitative analysis involves numerical data derived from laboratory experiments, such as degradation rates of different plastics (PET, HDPE, LDPE), AI prediction accuracy, enzyme activity, and environmental parameters (temperature, pH, humidity). Statistical techniques such as descriptive statistics (mean, standard deviation), inferential tests (t-tests, ANOVA), and regression analysis can be applied to determine significant differences, correlations, and predictive relationships between AI system parameters and plastic degradation outcomes (Creswell & Creswell, 2018).[9]

**Qualitative analysis**, on the other hand, interprets non-numerical data gathered from semi-structured interviews with engineers, operators, and sustainability officers, as well as observations of operational workflows. Techniques such as **thematic analysis** allow identification of recurring patterns, insights into adoption challenges, and perceptions of AI usability and environmental impact. Coding interview transcripts and categorizing themes can uncover critical factors that influence system effectiveness and organizational decision-making (Saunders, Lewis, & Thornhill, 2019).[10][11]

Combining both approaches through mixed-methods analysis enhances the robustness of findings by validating numerical results with stakeholder insights, providing a comprehensive understanding of AI-driven plastic degradation.[12]

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# Conclusion

## Conclusion

The proposed study on an AI-driven plastic degradation system highlights the potential of combining artificial intelligence with advanced biodegradation techniques to address the growing challenge of plastic waste. By employing a mixed-methods research approach, the study integrates quantitative data from laboratory experiments with qualitative insights from stakeholders, ensuring a comprehensive understanding of both technical performance and practical implementation challenges. Strategies to enhance validity, reliability, and generalisability, alongside careful attention to ethical considerations, will strengthen the credibility and applicability of the findings.

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