Chapter 5
AI and Applied Microbiology in Sustainable Waste Recycling and the Circular Economy

S. Anusha
Easwari Engineering College, India

B. Yamini
https://orcid.org/0000-0003-3531-108X
SRM Institute of Science and Technology, India

S. Udhayashankar
Vel Tech Multi Tech Dr. Rangarajan Dr. Sakunthala Engineering College, India

V. Priya
Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, India

M. Ezhilvendan
https://orcid.org/0009-0003-3213-1304
Panimalar Engineering College, India

R. Vinoth
https://orcid.org/0000-0001-5866-1395
R.M.K. College of Engineering and Technology, India

R. Siva Subramanian
https://orcid.org/0000-0002-7509-9223
R.M.K. College of Engineering and Technology, India

ABSTRACT

Recycling and sustainability are areas of paramount concern in the contemporary world and this paper explores the strategies of applied microbiology as well as artificial intelligence (AI) to enhance these methods. It brings into focus the notion of circular economy, which is of paramount importance in cyclical waste management that meets the least ecological influence and optimizes the resource utilization. The paper is grouped into the following segments: an outline of waste recycling and managerial aspects, the principles of sustainability, the role of applied microbiology in waste degradation, and the integration of artificial intelligence in waste sorting and recycling. Therefore, by adopting an interdisciplinary approach, it offers valuable insights to researchers, policymakers, and industry stakeholders, who are involved in the development of lasting and efficient waste management systems, which are based on the principles of circular economy.

DOI: 10.4018/979-8-3693-7282-1.ch005

I INTRODUCTION

1.1 Background on Environmental Hazards and the Need for Sustainable Practices

The increase in the rate of industrialization and urbanization has greatly contributed to the generation of waste at an alarming rate thus posing serious challenges to specific environments(Diksha, D., & Chakravarty, R. 2022). Current conventional management did landfills, incineration, and open dumping which exposed the environment to pollution, Green House gases, and unearthing scarce resources. In the case of landfills, a number of them are not well managed leading to emissions of toxic substances into the soil and ground water for case of incineration, the toxic emissions go to the atmosphere. Some of these practices impact directly on the ecosystems and pose adverse effects on the health of the public besides causing climate change. That is why the problems of environmental degradation call for urgent measures in the management of waste. In this case, sustainability is a measure that implies minimal impact in the environment, use of fewer resources and practices that do not harm the earth in the long run. This means that it is time to abandon the traditional non-circular waste management where waste is considered as the final result, and start using circular systems.

1.2 Definitions and Key Concepts

Waste Recycling: Waste recycling is therefore the practice of managing wastes whereby wastes are collected and then transformed to new products. This cuts on the procurement of raw materials, saves energy, and minimizes the flow of substances that end up in landfills. Waste recycling is a form of waste management that can be used for any type of waste such as paper, plastics, metals and organic wastes(Stefanakis, A. I., & Becker, J. A. 2016).

Sustainability: Sustainability focuses on usage and consumption in a manner that does not affect the ability of future generations to meet their needs. In waste management, it involves measures that are incorporated to minimize the generation of waste, encourage recycling and reusing of wastes and proper ways of disposing wastes in a manner that will not affect the environment negatively(Jayasutha et al 2024).

Circular Economy: The circular economy is a model of an economy that is designed to avoid wasting anything and to reuse everything possible(Martins-Rodrigues et al 2020). It is different from the linear economy that was evident previous to this period and strictly follows the 'take-make-dispose,' model. A circular economy entails a process of management where materials are constantly in use to provide value with the intention of being reused in the system. This model ensures sustainability because it does not compulsively take raw materials from the natural environment and also cuts down unnecessary production of wastes(Banaitė et al 2016).

1.3 Purpose and Scope of the Survey Paper

Thus, this survey paper will outline recent developments as regards waste recycling and sustainability with the emphasis made on the use of applied microbiology and artificial intelligence in this sphere. The scope of the paper includes: