

# Zero Waste: A New Sustainable Waste Management Philosophy in the 21st Century

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## Abstract

Zero waste is a system of principles that focuses on waste prevention to redesign resource lifecycles so that materials are reused, and wastes and pollutions are minimal that maximizes employment opportunities through the creation of relevant jobs. It is an idealistic concept that has become an aspirational goal for tackling waste problems. It indicates a 100% recycling and a 100% recovery of all resources from waste materials. It provides the greatest degree of local economic self-reliance that stimulates sustainable production and consumption, optimum recycling, and resource recovery. It is implemented in various sectors, such as waste management and treatment, mining, manufacturing, and urban development. It is one of the promising and effective ways to solve the waste management and recycling issues that represents a new planning method for the 21st century.

**Keywords:** zero waste, circular economy, environmental pollution, recycling, reuse

## 1. Introduction

In our society waste is unavoidable but objectionable. A complete reliable and efficient waste management method has not been achieved yet (Gutberlet, 2008). The waste generated from the industries, households, consumption, and constructions are the potential reason for environmental degradation in many parts of the world (Abedin & Jahiruddin, 2015). Waste management stands on the 5R principles: Refuse, Reduce, Reuse, Recycle, and Restore (Mohajan, 2020, 2021b). It is estimated that circular economy strategies through the zero waste (ZW) management will provide more than \$4 trillion in global economic benefits with 30-40% global greenhouse gas (GHG) emissions reduction (CCME, 2018).

The concept of ZW offers waste management, initially from the avoiding of trash, recycling, reduction and recovery of second-hand material. It is a process that designs and manages products systematically to avoid and eliminate the volume and toxicity of waste and materials to conserve and recover all resources, and not to burn or bury these (Kaza et al., 2018). It is pragmatic and visionary, and local and global target. It stimulates sustainable production and consumption, optimum recycling and resource recovery, and restricts mass incineration and landfilling (Zaman, 2015). It is a strategic vision of a community where all the raw materials in the system will be recycled, and will not end in an incinerator and landfills (Hazra, 2009).

Zero waste indicates that all materials are reused until the optimum level of consumption is reached (Mohajan, 2025a). It is a policy, a path, a direction, a process, and a target is a concept that aims to eliminate all waste (Townsend, 2010). It can also generate local jobs and business opportunities. Therefore, it is resource-efficient economy where material flows are cyclical and everything is reused and recycled harmlessly back into the nature (Raksha et al., 2018). It is also used in mining and resource extraction industries as an innovative technique to eliminate waste by applying advanced technologies, such as ZW polymer technology and ZW metal processing (Antrekowitsch & Steinlechner, 2011). It aims to rethink the way we produce and consume for the preservation

of the value and energy embedded in our resources to flourish the civilization (Awasthi et al., 2021).

## 2. Literature Review

A literature review is an overview of previously published works that is a piece of academic writing which demonstrate knowledge and understanding of the academic literature on a specific topic placed in context (Baglione, 2012). It involves researching, analyzing, and evaluating sources to identify relevant theories, methods, and gaps in the research (Galvan, 2015). Atiq Uz Zaman has realized that the scope of the ZW studies is diverse, and a ZW concept is constantly developing through various programs, plans, policies, and strategies. He has also wanted to identify priority areas of ZW strategy and to develop national zero waste guidelines that can be useful to policy and decision makers in developing the evidence-based ZW guidelines (Zaman, 2015). Abhishek Kumar Awasthi and his coauthors have discussed the aspects of waste management from a variety of perspectives and disciplines for rapid carbonization of agricultural waste, and several conceptual threads (Awasthi et al., 2021).

Paweł Dziekański and his coworkers have evaluated the spatial differentiation of the relationship between the green economy and the ZW concepts to reduce the burden on the environment by creating attractive conditions for living and business activities (Dziekański et al., 2023). Somnath Hazra has observed that the increasing rate of economic growth in the developing country increases per capita income that has a positive impact on the standard of living and population growth of the developing country, and the volume of waste increasing at an alarming. He emphasizes on the problems, disposal, and treatment of waste to develop the sustainable industrial ecology (Hazra, 2009). Julian Kirchherr and his coauthors have shown that ZW principles contribute to the circular economy that is an economic system that replaces the “end-of-life” concept with reducing, reusing, recycling and recovering materials in production, distribution and consumption phase of their life cycle (Kirchherr et al., 2017).

Katarina Novakovic and her coworkers have realized that the recycling of plastic packaging waste being a significant concern for the general public and governments worldwide. They have evaluated the present situation and have highlighted the bottlenecks that are limiting efficient recovery of plastic packaging waste using currently available systems. They have proposed that based on polyethylene terephthalate (PET), polypropylene (PP), high-density and low-density polyethylene new approaches of packaging are required to achieve a ZW circular economy for all plastic packaging (Novakovic et al., 2023). Raksha B. S. and her coauthors have noticed that the increase in the globalization and urbanization has led to increase in the lifestyle of the people that has led to an increase in the waste generation. They have wanted to realize the idea of ZW through an intensive literature review (Raksha et al., 2018).

## 3. Research Methodology of the Study

Research is a careful investigation, analysis, and interpretation of facts. It is creative and systematic work undertaken to increase the stock of knowledge. The goal of research is to discover new facts, revise theories, and apply new knowledge to practical problems (Sha, 2019). Methodology is a planned and structured procedure for solving a theoretical or practical problem. Research methods are specific procedures for collecting and analyzing data (Franklin, 2012). In this study a qualitative research method has used to establish ZW policy in the society (Silverman, 2011).

## 4. Objective of the Study

Zero waste is a principle that inspires discarded materials for reuse as commodities rather than for disposal, and conserving these commodities through waste prevention, reusing, recycling, composting, and other technologies (Hermansson, 2007). It has multiple perspectives, such as clean production, atmospheric protection, and resource conservation. The concept of it indicates that no material would be discarded as worthless (Murray, 2002). Therefore, ZW means no “waste” would be wasted under the circular economy system. The ZW policy is not properly implementing in the poor and developing countries (Zaman, 2015). Main objective of this article is to discuss ZW to eliminate material waste itself (Mohajan, 2025b). Other minor objectives of the study are as follows (Mohajan, 2018):

- 1) to highlight on ZW and its historical background,
- 2) to focus on ZW management, and
- 3) to discuss importance of ZW philosophy.

## 5. Zero Waste

At present many strategies of waste prevention, management, treatment, and assessment are identified to implement ZW environment in the society (Mohajan, 2021c). The ZW concept refuses incinerators, and landfills, and tries to bring an end to the throwaway society, instead of creating sustainable communities (Nizar et al., 2018). The ZW is defined as the conservation of all resources by means of responsible production, consumption,

reuse, and recovery of all products, packaging, and materials without burning them and with no discharges to land, water, and air that threaten the environment and human health (Zaman & Ahsan, 2019).

The ZW is one of the most studied and the most debated topic of waste management research in the last decades (Mohajan, 2015). It is a manifesto for the redesign of the material economy, and it is a set of tactics for realizing its principles in practice (Murray, 2002). It does not see “waste” as a substance that must be disposed of or incinerated but considers waste as a resource that should be used repeatedly. It is a visionary concept that advocates a systematic process of designing out waste and recovering resources from waste (Greyson, 2007). A ZW approach can reduce waste management emissions by 84%. Landfills and incinerators are a major source of GHG emissions (Glavic & Lukman, 2007).

## 6. Historical Background of ZW

From the time of the first Eve, it took human history over 3 million years to reach 1 billion people in the early 1800s. Now, we gain 1 billion people every 12-14 years and the world’s population grows by more than 200,000 each day and at present the world population become more than 8 billion, and half of them live in urban areas (Zaman & Lehmann, 2011; Mohajan, 2021d). The ZW movement began in the 1970s and 1980s with the work of US chemist Paul Palmer and US sociologist Daniel Knapp. It is created from the term Total Quality Management (TQM) for practices of production without any defects (Snow & Dickinson, 2003). It is based on the basis of the 5Rs: refuse, reduce, reuse, recycle, and rot. The term “zero waste” was coined by Paul Palmer in 1973 for recovering resources from chemicals, and he was also a founder of the Zero Waste Institute (Palmer, 2004).

In 1995, Daniel Knapp, founder of Urban Ore, took attempts to maximize materials recovery and minimize wasting by reusing, recycling, and composting everything currently being wasted. He has shared news of the Australian Capital Territory as “No Waste by 2010” to become the first program of its kind in the world, and Canberra became the first city in the world to adopt an official ZW target (Connett, 2013). In the same year, Lynn Landes set up the “Zero Waste USA” website that aimed at changing waste habits on an individual level, and the Grass Roots Recycling Network (GRRN) was also started by Bill Sheehan (Phillips et al., 2011). The Zero Waste New Zealand Trust established in 1997 that supported waste minimization initiated the ZW movement in New Zealand (Tennant-Wood, 2003).

In 2000, the larger ZW movement began to take place through the ZW conference that was held at the Kaitaia Community Centre in Kaitaia, New Zealand. In the same year, Del Norte County, California took on the first comprehensive ZW plans in the USA (Connett, 2013). In 2003, an international Zero Waste International Alliance (ZWIA) was formed in Beaumaris, Wales that has given the first working definition of ZW in 2004 that is developed further in a peer reviewed panel in 2009 as “*ZW means designing and managing products and processes to systematically avoid and eliminate the volume and toxicity of waste and materials, conserve and recover all resources, and not burn or bury them*” (ZWIA, 2009).

## 7. Zero Waste Management

Zero waste management focuses on reducing waste through the increased recycling, composting, donating, energy recovery, advanced waste treatment technologies, and reuse to mitigate the negative environmental impacts of waste with new cost efficiencies (Yoshida et al., 2012). It is a combination of integrated design and waste management philosophies. Recycling is one of the most important aspects of ZW that can reduce GHG emissions at the energy and transportation sectors (Gutberlet, 2008).

About one-third of the global waste is managed in environmentally unsafe manners, such as littering, open dumping, open burning, and unsanitary landfill (Mohajan, 2021a). About 85% of the global collected waste is sent to landfills, including uncontrolled landfills and open dumping, and only 15% of the collected waste is recycled (Zaman, 2023). The ZW does not mean that we would not create any “waste” in the transition of resource extraction, production, and consumption. But it means “no waste” would be wasted under the circular economy system (Achterberg et al., 2016).

## 8. Importance of ZW Philosophy

Zero waste systems reduce greenhouse gases (GHGs) by saving energy by reducing energy consumption associated with extracting, processing, and transporting raw materials and waste through the elimination of the need for landfills and incinerators (Song, 2016). It helps in the management of wastes in an efficient and environmentally friendly manner. It improves physical health and wellbeing, and reduces toxic chemicals (Lehmann, 2011).

Zero Waste encompasses producer responsibility, eco-design, waste reduction, reuse and recycling, all within a single framework (Ahsan & Zaman, 2014). It breaks away from the inflexibility of incinerator-centered systems and offers a new policy framework capable of transforming current linear production and disposal processes into

'smart' systems that utilize the resources in municipal waste and generate jobs and wealth for local economies (Murray, 2002). Millions of people of the world depend on collecting and recycling waste. In 2025, about \$375 billion is used for the worldwide waste management (Kaza et al., 2018).

## 9. Conclusions

Zero waste is a goal to end the generation of toxic and unnecessarily wasteful products through systemic redesign to reuse and recycling of discards for the creation of new products with many more new jobs. It stands on the basis of efficient technology and efficient social management through the coordination among producers and consumers, and governments and citizens. Incinerators release toxic dioxins and burning waste releases greenhouse gases (GHGs). Zero waste is a holistic approach to tackle waste problems in the 21st century, but it is still in development. Due to the increasing waste problems the global humanity is thinking to establish zero waste environments in the society, but at the same time, it is also very challenging to achieve.

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