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NOTE:

I tried to summarize everything as much as I could, however a report of just 5 pages was insufficient.

Waste Management in Japan: Policies, Innovations, and the 3R Initiative in a Sound-Material Society

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I. Introduction

Japan is facing a significant waste crisis, driven by its historical dependence on exporting plastic waste to other countries. Over time, Japan has built a complex waste management system, moving from individual waste handling to a more organized, government-regulated approach. A key part of this effort is the 3R Initiative, which aims to shift Japan from a wasteful, linear economy to a more sustainable, circular one. While progress has been made, challenges remain, including problems with waste separation, limited landfill space, and issues with enforcing policies. This report looks at Japan's past and present waste management practices, key policies like the Basic Law for Establishing a Recycling-Based Society, and the 3R Initiative, while highlighting the ongoing challenges and areas for improvement to build a more sustainable future.

II. Background and Context

History and Current State of Waste Management in Japan

Japan's waste management system has evolved significantly since the late 19th century, as demonstrated by Table 1. Initially, waste was treated by individual waste generators or private operators who collected and sorted waste for valuable materials.

However, this system often led to unsanitary conditions, causing the spread of infectious diseases. To address public health concerns, the Waste Cleaning Act of 1900 established municipal responsibility for waste collection and disposal, emphasizing incineration as a preferred method.

Period	Major issues	Laws enacted		
Post-war period to the 1950s	<ul style="list-style-type: none"> Waste management for environmental sanitation Maintenance of a healthy and comfortable living environment 	<ul style="list-style-type: none"> Public Cleansing Act (1954) 		
1960s to 1970s	<ul style="list-style-type: none"> Increase in the amount of industrial waste and emergence of pollution problems as a result of rapid economic growth Waste management for environmental protection 	<ul style="list-style-type: none"> Act on Emergency Measures concerning the Development of Living Environment Facilities (1963) Waste Management Act (1970) Revision of the Waste Management Act (1976) 		
1980s	<ul style="list-style-type: none"> Promotion of the development of waste management facilities Environmental protection required for waste management 	<ul style="list-style-type: none"> Wide-area Coastal Environment Development Center Act (1981) Private Sewerage System Act (Johkasoh Law) (1983) 		
1990s	<ul style="list-style-type: none"> Waste generation control and recycling Establishment of various recycling systems Management of hazardous substances (including dioxins) Introduction of a proper waste management system to cope with diversification in the type and nature of waste 	<ul style="list-style-type: none"> Revision of the Waste Management Act (1991) Act to Promote the Development of Specified Facilities for the Disposal of Industrial Waste (1992) Japanese Basel Act (1992) Basic Environment Act (1993) Containers and Packaging Recycling Act (1995) Revision of the Waste Management Act (1997) Home Appliance Recycling Act (1998) Act on Special Measures against Dioxins (1999) 		
2000-	<ul style="list-style-type: none"> Promotion of 3R measures aimed at the establishment of a sound material-cycle society Enhancement of industrial waste management Enhancement of illegal dumping regulations 	<ul style="list-style-type: none"> Basic Act for Establishing a Sound Material-Cycle Society (2000) Construction Recycling Act (2000) Food Recycling Act (2000) Revision of the Waste Management Act (2000) Act on Special Measures concerning Promotion of Proper Treatment of PCB Wastes (2001) Automobile Recycling Act (2002) Act on Special Measures concerning Removal of Environmental Problems Caused by Specified Industrial Wastes (2003) Revision of the Waste Management Act (2003 to 2006, 2010) Small Home Appliance Recycling Act (2013) 		

Table 1 History of legal systems regarding the development of a sound material-cycle society (post-war period to the present). From "History and Current State of Waste Management in Japan" (Ministry of the Environment, 2014)

During the post-war period (1945–1950s), rapid urbanization and economic growth led to a dramatic increase in waste generation. Waste management systems struggled to cope, resulting in widespread dumping in rivers, oceans, and vacant lots, prompting the enactment of the Public Cleansing Act in 1954. This act established a collaborative framework among national, local governments, and residents to address urban waste challenges.

In the 1960s and 1970s, Japan took its first significant step toward realizing the vision of a sound-material society with the introduction of the Waste Management Act of 1970. This act introduced key measures to distinguish between industrial and municipal waste¹, requiring businesses to take responsibility for managing their industrial waste. act marks as the first significant step for the sound-material society vision in modern Japan. In the 1980s and 1990s, Japan faced new challenges brought on by rapid industrialization and mass consumption.² This shift prompted a stronger focus on controlling waste generation,

¹ Industrial waste consists of 20 specific types (sludge, waste oil, waste acid, waste plastics... etc.), while municipal waste primarily includes household and small business waste.

² During this time, Japan experienced a speculative economic boom, known as the Bubble Economy period, characterized by inflated asset prices, high levels of investment, and rapid economic growth. The wealth and consumption associated with this period led to increased industrial activity and urbanization, which, in turn, resulted in a significant surge in waste generation.

promoting recycling, and managing hazardous substances. Landmark policies such as the Basic Environment Act (1993) and the Containers and Packaging Recycling Act (1995) laid the foundation for modern waste management practices in the country.

By the 2000s, Japan’s commitment to a sound material-cycle society gained momentum, with the promotion of 3R (Reduce, Reuse, Recycle) initiatives becoming central to waste management strategies. This period saw the introduction of various laws and programs aimed at reducing illegal dumping and improving industrial waste management. As a result, waste discharge volumes have steadily decreased over the past 20 to 30 years, as illustrated in Figure 1. This decline is largely attributed to the implementation of recycling acts, disposal fees, and other regulatory measures. However, with resources remaining finite, it is crucial to continue advancing sustainable practices to fully realize the vision of a sound material-cycle society.

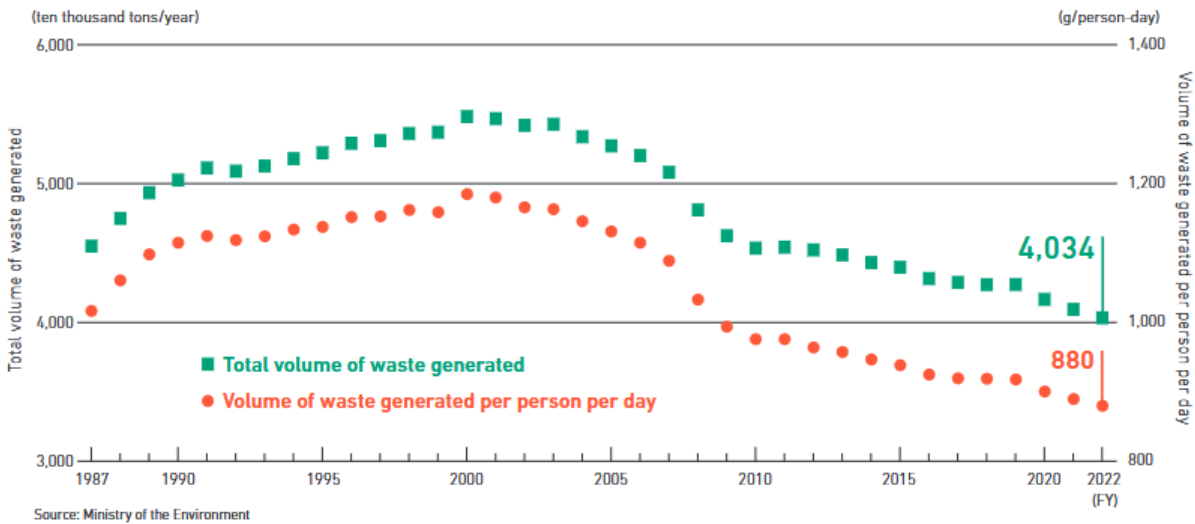


Figure 1 Total Volume of Waste Generation and Waste Volume Per Person Per Day. Annual Report on the Environment in Japan, (Ministry of Environment, 2024)

III. Japan’s Approach to Plastic Waste Management

The 3R Initiative (Reduce, Reuse, Recycle)

The 3R Initiative is the foundation of Japan's waste management philosophy, aiming to transition from a linear economy based on mass production, consumption, and disposal toward a sound material-cycle society as outlined in the Basic Act for Establishing a Sound Material-Cycle Society (Basic Recycling Act). This law emphasizes the 3R principles and

proper waste management to reduce natural resource consumption and environmental impact, while prioritizing resources and waste management strategies. The initiative focuses on:

- **Reduce:** Minimizing waste generation at the source.
- **Reuse:** Encouraging repeated use of materials and products.
- **Recycle:** Converting waste materials into reusable resources, including both material and thermal recycling. Material recycling processes include:
 - **Cascade Recycling:** This involves converting waste materials into products with different properties, such as using recycled plastics for furniture.
 - **Horizontal Recycling:** Commonly applied to PET bottles, where waste materials are processed back into their original forms.
 - **Thermal Recycling:** Waste materials unsuitable for material recycling are incinerated, and the heat generated is used for energy recovery.

Policies and Plans for a Recycling-Oriented Society

A key aspect of Japan's environmental strategy is shared responsibility, supported by the Basic Law for Establishing a Recycling-Based Society, enacted in 2001. This law provides a legal framework, as shown in Figure 2, for transitioning toward a recycling-oriented society and promotes:

- **Producer Responsibility:** Ensuring that manufacturers bear the cost of recycling their products.³
- **Extended Producer Responsibility (EPR):** Expanding manufacturers' responsibilities to include the end-of-life phase of their products.
- **Guidelines Development:** Encouraging manufacturers to design recyclable products and municipalities to promote sorted collection practices.

³ Businesses in Japan are specifically obligated to recycle PET bottles, plastic containers and packaging, glass bottles, and paper containers and packaging. However, materials like paper cartons, cardboard, aluminum, and steel cans are excluded from these obligations as they hold high resource value and can be sold for profit on the market (Arimura & Hibiki, 2024).

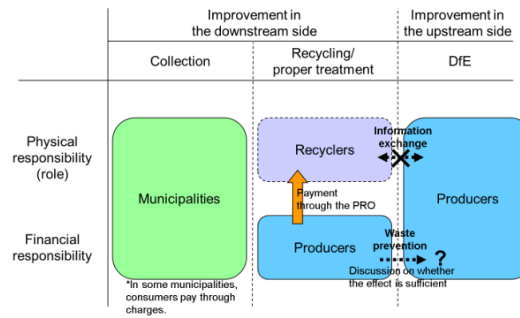


Figure 2 Responsibility and role-sharing under the Containers and Packaging Recycling Act (Designated Organization Route). Adapted from Tasaki (Tasaki, 2016).

Key Enacted Laws

Environmental policies and recycling initiatives in Japan are shaped by several key laws (Ministry of Environment, n.d.) targeting different waste categories. The Act on the Promotion of Sorted Collection and Recycling of Containers and Packaging mandates businesses and local governments to collect and recycle containers and packaging materials⁴, including PET bottles and plastics, ensuring efficient resource recovery.

The Law for the Recycling of Specified Kinds of Home Appliances requires manufacturers to properly recycle major household appliances, such as air conditioners, TVs, refrigerators, and washing machines. For smaller electronic devices, the Act on Promotion of Recycling of Small Waste Electrical and Electronic Equipment encourages local governments and businesses to facilitate the collection and recycling of small electronics, like mobile phones.

Recycling efforts also extend to the automotive sector through the Law for the Recycling of End-of-Life Vehicles, which mandates the dismantling and recycling of vehicles at the end of their lifecycle. In the construction industry, the Law on Recycling of Construction-Related Materials promotes the reuse of materials such as wood, concrete, and asphalt, reducing waste and conserving resources. Additionally, the Law for Promotion of Recycling and Related Activities for the Treatment of Cyclical Food Resources aims to minimize food waste and recycle food residues, contributing to a more sustainable waste management system.

⁴ Businesses can comply with the requirement by either recycling waste items themselves or paying a recycling fee to the Japan Containers and Packaging Recycling Association (JCPRA, n.d.), a government-designated organization established under the act.

IV. Challenges in Waste Management

Waste Separation and Recycling Efficiency

Effective recycling greatly depends on waste separation, as improper separation can reduce the efficiency of recycling systems, requiring better awareness campaigns and stricter enforcement. A recent study (Ishimura, Nomura, & Ichinose, 2024) demonstrated that reducing the complexity of separation standards increased collection volumes, as households were more likely to participate when the effort required was minimized. However, this simplification led to a decline in the quality of recyclables, with higher contamination rates during post-collection sorting. The findings emphasize a critical challenge in designing recycling policies: balancing the need to simplify processes for greater participation with maintaining high-quality recycling outputs. Addressing this requires comprehensive awareness campaigns, stricter enforcement of separation guidelines, and innovations in sorting technologies to offset the trade-offs between collection volume and recyclable quality.

Other studies (Minde, Kulkarni, Patil, & Shelake, 2024) (Mohamedsalih, Radwan, Alyami, & Abd El Aal, 2024) highlight the promising potential of using plastic waste in construction materials, particularly in concrete. As plastic waste continues to accumulate globally, incorporating it into concrete offers a sustainable solution that addresses both environmental and resource depletion challenges. Research shows that using plastic waste as a partial substitute for natural aggregates in concrete can reduce dependency on certain materials while providing an effective means of plastic waste disposal. For example, plastic fibers or granules can enhance specific properties of concrete, such as ductility, thermal resistance, and impact strength.

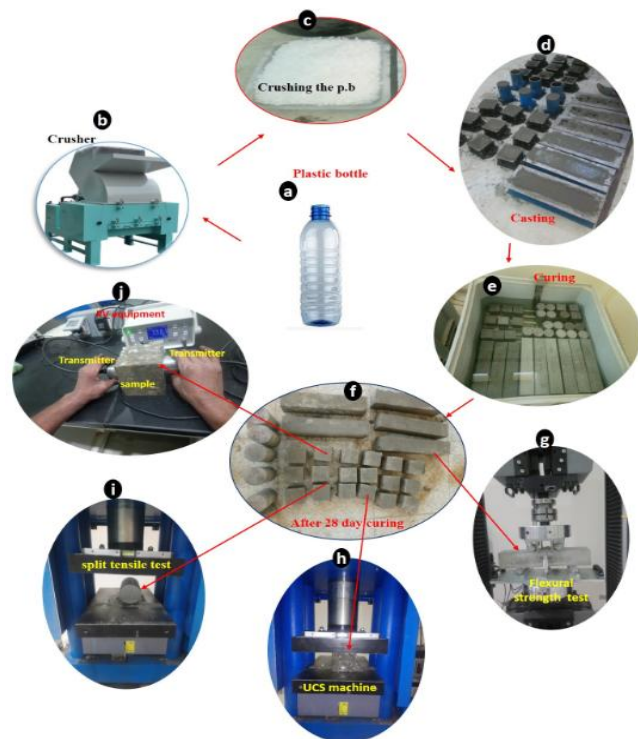


Figure 3 Methodological framework. The Use of Plastic Waste as Replacement of Coarse Aggregate in Concrete Industry (Mohamedsalih, Radwan, Alyami, & Abd El Aal, 2024)

Landfill and Hazardous Waste Issues

Landfills are classified into isolated, leachate-controlled, and non-leachate-controlled types based on the waste they handle. Isolated landfills manage hazardous industrial waste, leachate-controlled landfills handle municipal and non-hazardous industrial waste, and non-leachate-controlled landfills are used for stable materials like plastics and demolition waste. Each landfill type follows specific structural and operational standards (Ministry of Environment, n.d.).

Japan's critical shortage of final disposal sites underscores the urgent need to reduce reliance on landfills. The total volume of final disposal sites has been steadily declining over the years, with the number of facilities and their total capacities showing significant reductions. For instance, in Table 2, there were 1,223 facilities with a total capacity of 271,441 thousand cubic meters in 2014, down from 1,707 facilities in 1978 with a total capacity of 392,565 thousand cubic meters. (Ministry of the Environment, 2017)

	Mountains		Sea surface		Water surface		Flatlands		Total		Final disposal amount (1,000 t/yr.)	Final disposal site remaining volume (billion m)	Number of remaining years (yr.)
	# of Facilities	Total capacities (1,000 m)	# of Facilities	Total capacities (1,000 m)	# of Facilities	Total capacities (1,000 m)	# of Facilities	Total capacities (1,000 m)	# of Facilities	Total capacities (1,000 m)			
FY1978	1,707		39		59		872		2,677	392,565	19,900	2.39	9.8
1979	1,583		39		54		799		2,475	425,761	20,352	2.14	8.6
1980	1,600		36		50		796		2,482	356,109	19,715	1.92	7.9
1981	1,619		40		48		779		2,486	403,156	17,250	1.82	8.6
1982	1,612		36		46		778		2,472	377,583	18,188	1.76	7.9
1983	1,638		34		41		766		2,479	382,728	16,763	1.71	8.3
1984	1,633		37		38		731		2,439	403,062	16,196	1.74	8.8
1985	1,630		38		42		721		2,431	410,096	16,048	1.96	10.0
1986	1,629		36		39		707		2,411	429,895	16,020	2.07	10.6
1987	1,637		31		35		692		2,395	423,858	16,486	1.95	9.7
1988	1,628		35		34		676		2,373	414,278	16,897	1.71	8.3
1989	1,601		34		31		668		2,334	424,535	17,008	1.67	8.0
1990	1,617		33		33		653		2,336	415,622	16,809	1.57	7.6
1991	1,567		31		29		623		2,250	420,219	16,379	1.57	7.8
1992	1,639	269,679	33	101,103	29	2,880	662	62,044	2,363	435,705	15,296	1.54	8.2
1993	1,621	273,033	32	101,818	26	2,560	642	59,862	2,321	437,273	14,959	1.49	8.1
1994	1,675	289,180	31	101,808	26	3,672	660	63,372	2,392	458,032	14,142	1.51	8.7
1995	1,683	293,194	30	100,956	22	3,573	626	64,913	2,361	462,636	13,602	1.42	8.5
1996	1,692	301,166	31	99,679	24	3,548	641	72,624	2,388	477,017	13,093	1.59	9.9
1997	1,620	297,908	33	119,069	24	3,548	589	71,816	2,266	492,341	12,008	1.72	11.7
1998	1,546	300,340	32	119,094	21	3,460	529	70,607	2,128	493,501	11,350	1.78	12.8
1999	1,503	293,985	30	138,303	19	3,438	513	65,442	2,065	501,168	10,869	1.72	12.9
2000	1,520	289,326	30	108,903	18	3,048	509	70,442	2,077	471,719	10,514	1.65	12.8
2001	1,504	287,137	29	110,668	17	2,844	509	68,054	2,059	468,702	9,949	1.60	13.2
2002	1,499	287,712	28	110,637	19	2,924	501	68,127	2,047	469,400	9,030	1.53	13.8
2003	1,491	290,460	27	109,820	17	2,848	504	68,815	2,039	471,943	8,452	1.45	14.0
2004	1,464	286,843	25	92,076	16	2,937	504	67,638	2,009	449,493	8,093	1.38	14.0
2005	1,343	271,340	24	110,787	15	3,061	465	64,423	1,847	449,611	7,328	1.33	14.8
2006	1,349	273,094	25	117,340	13	3,016	469	63,766	1,853	457,217	6,809	1.30	15.6
2007	1,333	272,375	23	100,008	14	13,308	462	63,815	1,832	449,507	6,349	1.22	15.7
2008	1,321	278,832	26	100,264	11	11,177	465	65,515	1,823	455,788	5,531	1.22	18.0
2009	1,298	275,148	28	117,743	9	873	465	67,330	1,800	461,095	5,072	1.16	18.7
2010	1,281	274,539	26	117,479	10	1,119	458	67,473	1,775	460,610	4,837	1.14	19.3
2011	1,274	274,253	26	117,479	9	1,104	463	68,249	1,772	461,088	4,821	1.11	18.9
2012	1,262	272,313	26	117,479	9	1,106	445	68,098	1,742	458,996	4,648	1.12	19.7
2013	1,243	268,486	25	127,112	9	1,106	446	68,124	1,723	464,829	4,538	1.07	19.3
2014	1,223	271,441	26	127,113	9	1,106	440	67,514	1,668	467,174	4,302	1.06	20.1

Table 2 Changes in Total Volume of Final Disposal. Annual Report on Environmental Statistics 2017. (Ministry of the Environment, 2017) p. 147.

V. Conclusion

Japan has made commendable progress in waste management through initiatives like the 3R program and the enactment of recycling laws. However, challenges such as inefficient waste separation, limited landfill capacity, and policy enforcement gaps remain significant. A continued focus on innovation, public participation, and stricter enforcement will be essential for Japan to achieve its goal of a sustainable, recycling-oriented society.

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