

Waste Management in the Aviation Industry: A Review of Innovative Practices with Insights from Turkey and Serbia¹

Irina Rucnov

Education Support Association InterEdu

Abstract

Waste generation has become an increasingly important sustainability challenge for the aviation industry, alongside the more widely discussed issues of emissions and fuel efficiency. Airports and airlines generate substantial volumes of municipal, catering, maintenance, and construction waste, requiring systematic approaches to prevention, reuse, recycling, and recovery. This paper reviews innovative waste management practices in the aviation sector, drawing on international guidelines from ICAO and IATA, and examines the waste hierarchy as applied to aviation-specific waste streams, including aircraft cabin waste, terminal waste, maintenance-repair-overhaul (MRO) waste, and construction and demolition waste. Through a comparative analysis of good practice, the paper presents Turkey's national Zero Waste Project and its implementation at Istanbul Airport and Turkish Airlines, alongside Serbia's progress at Belgrade Nikola Tesla Airport following its concession to VINCI Airports, where the recycling rate increased from approximately 5% in 2019 to around 70% by 2023 (VINCI Airports, 2019–2023). The comparison highlights common success factors — waste prevention, source separation, digital monitoring, and multi-stakeholder cooperation — and identifies opportunities for further development, particularly in Serbia, where recycling infrastructure and passenger awareness remain areas for improvement. The findings confirm that sustainable waste management has become an integral component of modern airport and airline operations, contributing to environmental protection, regulatory compliance, and operational efficiency.

Keywords: *Aviation waste management; circular economy; airport sustainability; waste hierarchy; recycling; Turkey; Serbia*

1. Introduction

The aviation industry plays a vital role in connecting people, supporting global trade, and contributing to economic development. As air travel continues to grow, airports and airlines face increasing environmental challenges associated with their operations. While much of the public and scientific attention has focused on reducing greenhouse gas emissions and improving fuel efficiency, waste generation has become another significant sustainability issue. Large volumes of municipal, catering, maintenance, and packaging waste are produced daily by airports, airlines, and ground handling services, creating environmental, economic, and operational challenges.

Waste generated throughout the aviation sector originates from multiple sources, including passenger terminals, aircraft cabins, maintenance activities, retail facilities, and airport restaurants. In addition to conventional solid waste, aviation operations generate hazardous waste, food waste, plastics, metals, textiles, and electronic equipment. The complexity of airport operations, strict international regulations regarding catering waste, and increasing passenger numbers make effective waste management

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particularly challenging. Consequently, the aviation industry is gradually shifting from traditional waste disposal practices toward more sustainable approaches based on the principles of waste prevention, reuse, recycling, and resource recovery.

Recent years have seen the emergence of numerous innovative initiatives aimed at reducing waste generation and promoting circular economy principles within aviation. Airlines and airports are implementing digital technologies to minimize paper consumption, replacing single-use plastics with reusable alternatives, improving waste separation systems, optimizing catering processes to reduce food waste, and investing in recycling and waste-to-energy solutions. These practices not only reduce environmental impacts but also improve operational efficiency, decrease disposal costs, and strengthen corporate sustainability performance.

International organizations, including the International Civil Aviation Organization and the International Air Transport Association, encourage the adoption of sustainable waste management strategies as part of broader environmental management frameworks (ICAO, 2022; IATA, 2022). Their guidelines emphasize that waste prevention should remain the highest priority, followed by reuse, recycling, and recovery, in accordance with the waste hierarchy concept (European Commission, 2008).

The aim of this paper is to review innovative approaches to waste reduction, recycling, reuse, and recovery within the aviation sector through the analysis of selected best practices and case studies. By examining successful initiatives implemented by leading airports and airlines, the paper identifies practical strategies that contribute to more sustainable airport and airline operations. Furthermore, the study highlights key lessons learned and discusses opportunities for wider implementation of circular economy principles in the aviation industry.

2. Methodology

This paper is based on a review of secondary sources, including guidance documents and environmental reports published by international aviation bodies (ICAO, IATA), the applicable EU waste framework legislation, and publicly available sustainability disclosures from the two case-study organizations — İGA Istanbul Airport, Turkish Airlines, and VINCI Airports (as concessionaire of Belgrade Nikola Tesla Airport). Turkey and Serbia were selected as a comparative pair because they represent, respectively, a mature national zero-waste framework and a rapidly modernizing system undergoing concession-driven transformation, allowing common success factors to be identified across two different stages of development.

3. Aviation Waste: Definitions and Classification

Waste can generally be defined as any material, product, or substance that is no longer needed and requires appropriate collection, treatment, or disposal. In the aviation sector, waste is generated from a wide range of activities, including aircraft operations, passenger terminals, catering services, maintenance, administrative offices, ground support operations, retail facilities, and construction projects.

There is no universally accepted definition of waste, as its interpretation varies across legal frameworks, industries, and countries. In general, waste refers to materials that are discarded because they have no further intended use. International agreements, such as the Basel Convention, define waste as substances or objects that are disposed of, intended for disposal, or required by law to be disposed of (Basel

Convention, n.d.). The Convention also emphasizes that waste should be managed in a manner that protects both human health and the environment.

Within the aviation industry, waste management presents additional challenges due to the distinction between domestic and international waste, as well as between hazardous and non-hazardous waste. Many countries have specific regulations governing waste generated on international flights because of potential biosecurity and public health risks (WOAH, n.d.). Hazardous waste, including materials that are flammable, toxic, corrosive, or otherwise dangerous, is subject to even stricter handling, transportation, and disposal requirements under both national legislation and international agreements.

Waste generated within the aviation sector is highly diverse due to the wide range of activities performed at airports and by airlines. It originates from passenger services, aircraft operations, maintenance activities, commercial facilities, and airport infrastructure. The classification of aviation waste is essential for selecting appropriate handling, treatment, and disposal methods, as different waste streams are subject to different environmental and legal requirements.

One of the most common classifications distinguishes waste according to its source.

Aircraft waste includes cabin waste generated during flights, such as food leftovers, disposable catering items, paper products, plastic packaging, and beverage containers. International flights often produce waste that is subject to stricter biosecurity regulations because it may contain food products or materials that pose a risk of introducing animal or plant diseases (WOAH, n.d.; IATA, n.d.).

Terminal waste is generated within airport buildings and consists mainly of municipal solid waste produced by passengers, airport staff, restaurants, retail shops, and office activities. Typical materials include paper, cardboard, plastics, glass, metals, and food waste. Since this waste is similar to municipal waste generated in urban areas, it offers considerable opportunities for recycling and composting when effective waste separation systems are implemented.

Another important category is maintenance, repair, and overhaul (MRO) waste, which is produced during aircraft maintenance and servicing. This waste stream includes scrap metals, composite materials, used oils, lubricants, solvents, batteries, electrical components, and chemical residues. Many of these materials are classified as hazardous waste because they may contain toxic, flammable, or corrosive substances requiring specialized treatment and disposal.

Construction and demolition waste is generated during airport expansion, renovation, and infrastructure projects. It typically consists of concrete, asphalt, steel, wood, glass, and construction debris. A significant proportion of these materials can be recovered or recycled, supporting circular economy principles and reducing landfill disposal (European Commission, n.d.).

Waste can also be classified according to its environmental characteristics. Non-hazardous waste includes recyclable materials such as paper, cardboard, plastics, glass, and metals, as well as organic waste suitable for composting or energy recovery. In contrast, hazardous waste comprises substances that present risks to human health or the environment, including chemicals, fuels, paints, solvents, contaminated absorbents, medical waste, and certain electronic equipment. Hazardous waste is subject to strict national and international regulations governing its storage, transportation, treatment, and disposal (European Commission, 2008).

Understanding these waste categories enables airports and airlines to implement targeted waste management strategies based on the principles of waste prevention, reuse, recycling, recovery, and safe

disposal. Proper classification also supports regulatory compliance, improves recycling rates, and contributes to more sustainable airport operations.

4. Innovative Waste Management Practices: Case Studies

Effective waste management has become an essential component of sustainable aviation. Rather than relying solely on waste disposal, leading airports and airlines increasingly adopt circular economy principles that prioritize waste prevention, reuse, recycling, and resource recovery. These practices not only reduce environmental impacts but also improve operational efficiency, lower waste management costs, and strengthen compliance with national and international environmental regulations. The following sections present selected examples of good practice, focusing on Turkey and Serbia while relating them to broader international trends.

4.1 General Best Practices in Aviation

Successful waste management begins with waste prevention. Airports and airlines are reducing waste generation by replacing printed documents with digital boarding passes, electronic baggage tags, and paperless operational systems. Digitalization significantly decreases paper consumption while simplifying passenger processing and reducing administrative costs (IATA, 2022).

Another important practice is the reduction of single-use plastics. Many airlines have replaced disposable cutlery, cups, stirrers, and packaging with reusable or recyclable alternatives. Catering companies increasingly use lightweight packaging and optimize meal loading based on passenger demand, reducing both food waste and aircraft weight. Since lower aircraft weight decreases fuel consumption, waste prevention also contributes indirectly to lower greenhouse gas emissions.

Waste separation at the source is another widely adopted practice. Airports install clearly labelled collection points for paper, plastics, metals, glass, organic waste, and hazardous materials throughout passenger terminals and operational areas. Proper separation increases recycling rates while reducing contamination of recyclable materials.

Modern airports are also implementing circular procurement principles by purchasing products made from recycled materials, extending the lifespan of equipment through maintenance and refurbishment, and encouraging suppliers to minimize packaging. Several airports have introduced waste-to-energy systems or composting facilities for organic waste, further reducing dependence on landfill disposal (ICAO, n.d.).

These initiatives demonstrate that effective waste management requires cooperation among airport operators, airlines, catering companies, retail tenants, cleaning contractors, passengers, and regulatory authorities. The most successful airports integrate waste management into their overall environmental management systems instead of treating it as an isolated operational activity.



Waste Assessment Approaches	
Strengths	Limitations
Records Examination - Provides weights and volumes of waste generated - Tracks major potential waste from the point of origin - Identifies the expensive or valuable components of an organization's waste - Documents financial benefits of reuse and recycling including total revenues and avoided disposal costs - Requires the least time and effort - Establishes baseline for metrics	- Lack of quantitative data for specific waste components - Does not provide qualitative data on how or why wastes are generated - Substantial effort necessary to collect and analyze data
Facility Walk-Through - Requires less time and effort than waste sorts - Allows first-hand examination of facility operations - Provides qualitative information about major waste components and waste-generating processes - Reveals waste reduction activities - Develops appreciation of logistics and obstacles tenants encounter in their efforts to recycle	- Limited identification of wastes generated - Multiple attempts may be necessary for comprehensive evaluation - Relies on estimates of waste generation
Waste Sort - Provides quantitative data on total waste generation and specific waste components - Allows problem solving and design of recycling program to be site specific	- Requires more time and effort than other approaches - Multiple attempts may be necessary for comprehensive evaluation - Does not provide qualitative data on how or why wastes are generated

Source: USEPA, *Business Guide for Reducing Solid Waste*, 1993.

4.2 Turkey: A Regional Example of Good Practice

Turkey has become one of the regional leaders in sustainable airport management, particularly following the introduction of the national Zero Waste Project (Sıfır Atık Projesi). The programme encourages public institutions and businesses to improve waste separation, recycling, and resource efficiency through standardized waste management systems (Republic of Türkiye, Ministry of Environment, Urbanisation and Climate Change, n.d.).

Istanbul Airport has incorporated these principles into its environmental management strategy. Separate collection systems are installed throughout the terminal for recyclable materials, organic waste, and hazardous waste. Waste generated by passengers, restaurants, retail outlets, and airport operations is collected separately before being transferred to licensed recycling and waste treatment facilities. Continuous monitoring enables the airport to measure waste generation and improve recycling performance over time (İGA Istanbul Airport, 2023).

An important feature of Istanbul Airport's approach is the integration of waste management with digital monitoring systems. Data collected from waste operations support planning and resource allocation while identifying opportunities for further waste reduction. Employee training and passenger awareness campaigns also play an important role in improving waste segregation and encouraging environmentally responsible behaviour (İGA Istanbul Airport, 2023).

Turkish Airlines complements airport initiatives through its own sustainability programme. The airline has introduced measures to reduce single-use plastics, improve recycling of cabin waste, optimize catering services, and reduce food waste. Digital documentation has significantly decreased paper consumption in flight operations and administrative processes. The airline also collaborates with suppliers to develop more sustainable packaging and increase the use of recyclable materials throughout its service chain (Turkish Airlines, 2023).

Food waste management represents another important area of innovation. By using passenger demand forecasting and improved catering logistics, Turkish Airlines aims to reduce unnecessary meal loading while maintaining service quality. This practice reduces both waste generation and aircraft weight, creating environmental and economic benefits simultaneously (Turkish Airlines, 2023).

Turkey's experience demonstrates that successful aviation waste management depends not only on technological solutions but also on national environmental policies, strong regulatory frameworks, and cooperation between airports, airlines, and public authorities.

4.3 Serbia: Current Practices and Future Opportunities

Compared with Turkey, Serbia is still at an earlier stage of implementing comprehensive aviation waste management programmes. Nevertheless, significant progress has been achieved at Belgrade Nikola Tesla Airport following the concession agreement with VINCI Airports.

Environmental management has become one of the airport's strategic priorities, with objectives that include reducing waste generation, increasing recycling rates, improving wastewater treatment, promoting circular economy principles, and achieving zero waste to landfill by 2030. These goals are aligned with VINCI Airports' global environmental strategy and international sustainability standards (VINCI Airports, 2019–2023).

One of the most important improvements has been the construction of dedicated waste management facilities on both the landside and airside of the airport. These transfer stations allow waste generated by passengers, airport staff, aircraft operations, and commercial activities to be sorted before being transferred to authorized recycling operators. The airport currently separates multiple recyclable waste streams, including paper, cardboard, PET bottles, aluminium cans, glass, metal packaging, plastic foil, tetra pak packaging, and hard plastics (VINCI Airports, 2019–2023).

According to VINCI Airports, Belgrade Airport increased its waste recycling rate from approximately 5% in 2019 to around 70% by 2023 through improved waste segregation systems and new recycling infrastructure (VINCI Airports, 2019–2023). This represents one of the most significant environmental improvements implemented during the modernization programme.

Hazardous waste generated through aircraft maintenance and airport operations is handled separately in accordance with Serbian legislation and international environmental requirements. The airport also monitors wastewater quality, operates wastewater treatment facilities, and promotes water reuse for irrigation purposes, demonstrating an integrated approach to environmental management rather than focusing exclusively on solid waste (VINCI Airports, 2019–2023).

Despite these achievements, Serbia still faces several challenges. Recycling infrastructure outside major urban areas remains less developed than in many European countries, and stronger cooperation between airports, airlines, waste management companies, and local authorities will be necessary to further improve recycling performance. Passenger awareness regarding waste separation also remains an important area for future development.

Additional opportunities include introducing smart waste collection systems, expanding circular procurement practices, increasing reuse of airport equipment and furniture, improving food waste recovery, and applying artificial intelligence to optimize catering logistics and waste forecasting. These measures have already demonstrated positive results at several European airports and could be gradually adapted to Serbian conditions.

5. Lessons Learned

The comparison between Turkey and Serbia illustrates different stages of sustainable aviation waste management. Turkey demonstrates the benefits of combining national environmental policy with airport and airline initiatives, while Serbia illustrates how significant improvements can be achieved through investment, international partnerships, and adoption of global environmental standards.

Several common success factors can be identified. First, waste prevention is more effective than relying solely on recycling. Second, separating waste at the source substantially improves recycling efficiency. Third, digital technologies support better monitoring, reporting, and decision-making. Finally, long-term success depends on cooperation among all stakeholders, including airport operators, airlines, concessionaires, government authorities, service providers, and passengers.

These examples confirm that sustainable waste management is no longer limited to environmental protection but has become an important component of modern airport management, improving operational efficiency, regulatory compliance, and corporate sustainability performance.

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