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# An Actor-Based Systematic Review of Airport Waste Producers: Sources, Characteristics, and Spatial Distribution

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## ABSTRACT

As critical infrastructure that facilitates air transport connectivity and supports regional and national economic development, airports are complex socio-technical environments with diverse activities generating considerable and heterogeneous waste streams due to interactions with multiple operational actors within the complex aviation systems. Although research on waste management is growing, the sources and spatial distribution of airport waste producers remain inadequately synthesised, particularly in developed countries, with limited attention given to systematic review identifying airport waste-producing actors, and examining the characteristics of the waste generated. This study undertook an actor-based systematic review to identify the major airport waste producers, their associated waste characteristics, spatial distribution, and assess the implications for sustainable airport waste management.A systematic literature review approach guided by the PRISMA framework was employed to synthesise evidences from academic publications, institutional reports, and relevant aviation and environmental literature published between year 2000 and 2025. Following duplicate removal, title and abstract screening, full-text eligibility assessment, and final selection, thirty-seven (37) studies were subjected to thematic analysis. The review identified six major categories of airport waste-producing actors: passengers and passenger-related activities, airlines and aircraft operations, airport authorities and administrative activities, airport concessionaires and commercial operators, airport maintenance and technical service activities, and cargo and logistics operations. The analysis classified the waste producers according to their operational roles. The findings indicate that these actors generate distinct waste streams with varying material characteristics and spatial distributions across airport environments. Passenger and commercial activities were particularly associated with municipal, food, and packaging wastes in terminal areas, while airline, maintenance, and cargo operations generated more specialised, technical, regulated, and packaging-related waste streams across aircraft, airside, technical, and cargo areas. The findings highlight the limitations of generalised waste-management approaches and demonstrate the need for actor-specific and location-specific interventions. The study contributes to airport sustainability literature by applying an agent-based perspective and integrating material-flow and integrated solid-waste-management perspectives to explain the relationship between waste-producing actors, waste characteristics, spatial distribution, and management requirements. The findings provided an actor-based and spatially informed basis for developing targeted segregation, recycling, resource-recovery, and waste governance strategies and establishes a foundation for future empirical investigation of airport waste generation and management, particularly in Nigerian international airports.

**Keywords**: Airport waste, waste generation, waste producers, waste management, aviation sustainabile waste management, spatial distribution, circular economy

## BACKGROUND TO THE STUDY

In the 21st century, airports have evolved from conventional transportation facilities into multifunctional transport hubs because of the expansion of airport activities and have become critical engines of global socioeconomic development through efficient air transport services (Hanedar et al., 2026). These services integrates ongoing functional activities, logistics, business processes, hospitality, catering, and retail shopping, with passenger and cargo transportation (de Oliveira et al., 2024). The revolution, along with continued growth of air travel, increased the magnitude and multiplicity of activities within airport environments (Sreenath et al., 2021), making environmental sustainability and waste management an increasingly important dimension of airport operations and development (International Civil Aviation Organisation [ICAO], 2024)

As airport activities continue to expand, the volume and diversity of waste generated within airport environments have increased. The diverse activities within airport environments generate heterogeneous waste streams, including organic waste, paper, plastics, metals, glass, and hazardous materials (International Air Transport Association [IATA], 2021). Unlike conventional waste, airport waste is produced by multiple interconnected actors operating within spatially differentiated zones of the airport systems (Grewe et al., 2021). These waste producers generate distinct waste streams with varying characteristics, management requirements, and environmental implications. The disposal of large amounts of waste generated is a pressing issue for the green development of the aviation industry (Zorpas, 2023).

In several countries, airports are increasingly integrating sustainable waste management strategies, such as source segregation, recycling, composting, and circular economy initiatives, into their operations (Tjahjono et al., 2023). However, the effectiveness of this approach depends strongly on understanding waste origins, the producers, types of waste generated, and how it varies across airport operational spaces.

Waste generated within airport functional areas differs both in composition and management requirements (Sebastian and Louis, 2021). An actor-based perspective is therefore necessary as it will offer supplemental insights into airport waste generation and support the development of targeted waste-management interventions.

Regardless of the growing interest in sustainable airport operations, literature on airport waste remains disjointed. Existing studies examined waste generation, composition, management practices, environmental impacts, and sustainability initiatives. Comparatively, limited attention has been paid to systematically identifying the actors responsible for waste generation and relating these actors to the characteristics and spatial contexts of the waste produced.

The knowledge gap is significant in emerging economy settings, including Nigeria, where waste-management challenges are already substantial across urban and institutional environments. Although Nigerian airports constitute important economic and transportation infrastructures, empirical research specifically addressing airport waste remains limited and geographically concentrated (Abdullahi & Kachalla, 2024). Existing studies provide useful evidence on particular aspects of airport waste and its environmental or health implications. However, there is limited systematic synthesis of the different waste-producing actors, the characteristics of the waste associated with them, and the spatial contexts in which waste is generated. Thus, the existing evidence does not yet provide a sufficiently integrated actor–waste–space perspective for understanding airport waste generation.

Against this background, an actor-based systematic review is necessary to consolidate the fragmented evidence on airport waste. This study addressed this gap by reviewing three interrelated dimensions: the sources or actors responsible for waste generation, the characteristics of the waste produced, and its spatial distribution within airport environments. The significance of this study lies in its contribution to the growing discourse on sustainable waste management within airport environments. It contributes to academic literature by extending actor-based and material-flow perspectives to airport waste management research, particularly in developing countries such as Nigeria, where empirical studies remain limited. The findings are expected to provide useful evidence for airport authorities, environmental managers, policy-makers, and regulatory agencies to comprehend the major sources and characteristics of waste in the airport surroundings, thereby supporting the development of targeted and sustainable waste management strategies.

## LITERATURE REVIEW

### Concept of Airport Stakeholders

The concept of stakeholders refers to any group or individual who can affect or is affected by the achievement of the organisation's objectives. Airports operate in a multi-stakeholder environment involving diverse actors whose activities collectively influence operational efficiency and environmental sustainability (Sulaman, 2014). Through a review of the literature, Schaar and Sherry (2010) described a comprehensive list of airport stakeholders. They are passengers, air carriers, general aviation users, airport organisations, investors and bond-holders, concessionaires, service providers, employees, the federal government, and local government. Communities affected by airport operations, Non-Governmental Organisations [NGOs], parking operators, ground transportation providers, and airport suppliers. Graham (2018) classified airport stakeholders as passengers, airlines, concessionaires, airport authorities, cargo operators, and maintenance units, each performing distinct functions within the airport system.

From a waste management perspective, airport stakeholders include the airport authorities, airlines, concessionaires, ground handlers, tenants, passengers, and regulatory bodies (Baxter et al., 2018). These stakeholders are not merely airport users but active waste producers whose consumption patterns, operational activities, and service functions contribute to the generation of heterogeneous waste streams. They collaborate to handle municipal solid waste and hazardous materials to achieve sustainability goals. The stakeholder concept is relevant to airport waste studies because it enables the identification and classification of waste-generating actors within the airport.

**Agent-Based Perspective Theory**

The agent-based approach views an organisation as a collection of agents, interacting with one another in their pursuit of assigned tasks. The theory is a social interaction between heterogeneous agents/actors embedded in social structures, such as social networks, spatial neighbourhoods, or institutional scaffolds (Bianchi & Squazzoni, 2015). In the airport environments, different stakeholders function as agents whose activities contribute to varying waste generation patterns. The interaction of these agents within airport spaces creates a dynamic waste generation system characterised by multiple waste flows and management challenges.

The relevance of the agent-based perspective to this study lies in its ability to explain airport waste generation as a decentralised and actor-driven process rather than a uniform institutional output. This perspective supports the development of targeted waste management strategies tailored to specific waste producers.

**Material Flow Theory (MFA)**

This theory conceptualises systems as networks of material inputs, stocks, and outputs, enabling the quantification and tracing of resources from entry to disposal. It is grounded in mass-balance principles, where all material inflows equal accumulated stocks plus outflows, including waste. MFA is a robust tool for mapping waste streams, identifying inefficiencies, and supporting resource recovery in complex systems (Brunner & Rechberger, 2016; Allesch & Brunner, 2015). MFA provides a framework to quantify waste generated across airport subsystems (terminals, aircraft, cargo), estimate generation rates (e.g., kg/passenger/day), and identify dominant waste fractions. It strengthens the empirical rigour of waste characterisation and highlights leakage points where materials are lost instead of recovered.

ISWM complements MFA by guiding how identified waste streams should be managed through reduction, segregation, recycling, and safe disposal. It enables classification of airport waste into functional streams (organic, recyclable, and hazardous) and supports evaluation of current handling practices and system gaps (Kaza et al., 2018; Wilson et al., 2021). MFA diagnoses what and how much waste is generated; ISWM prescribes how it should be managed, making them jointly essential for this study.

**Airport Waste Producers**

Waste management is a critical environmental facing airports due to the large amount of waste produced by its many activities (Dimitrious and Voskaki, 2010). In the agent- based perspective, the classification of producers of airport waste involves the behaviour of many stakeholders (Booranakittipinyo et al., 2024). Reiterating, Zixin et al., 2025 asserted that airport waste classification involves a large number of stakeholders with complex influencing factors. Sierra et al (1981) identified that the sources of airport waste are from airport activities that produce waste water from aircraft maintenance (servicing, maintenance, overhauling and washing), aircraft operations, fuel storage areas, airport terminal building facilities, and auxiliary facilities.

Li et al. (2003) asserted that waste is generated from in-flight services in the airline industry and estimated it to be up to 500kg per flight, including food waste and galley and cabin waste, while its composition analysis showed paper (newspapers, meal menus, and cards) and plastic items. A study carried out by the Natural Resources Defence Council [NRDC] (2006) elucidated that airport waste producers are the aeroplanes, airport authority office waste, shops, restaurants, restrooms, flight kitchens, cargo operations, maintenance areas, and hangars, landscaping, construction, and demolition.

Goodwin and Godson (2014) elucidated that one of the airport waste is the aircraft cabin waste, and went further to address the lack of data on cabin waste characteristics (weight and composition), and to design and implement a standard methodology for auditing cabin waste. Mehta (2015) categorised waste from airports into eight (8) namely municipal solid waste which includes everyday items, construction and demolition waste which are non-hazardous and from land clearing, excavation, construction, demolition, renovation or repair of structures, roads, and utilities areas inside the airport generating materials like concrete, wood, glass, carpets,

piping, debris, and salvaged building components, green waste mostly generated from the air side operations of the airport includes, trees, shrubs, grass clippings, leaves, and weeds, food waste mainly generated from in-flight kitchens, discarded during food preparation activities, and leftovers from flights, aircraft wastes that is removed from passenger aircraft. These materials include bottles and cans, newspaper, mixed paper, wrappers, plastic cups, service wares, paper towels, and napkins, lavatory waste generated when the lavatory tanks of the airplanes are emptied via hose and pumped into a lavatory service vehicles, spill cleanup and remediation waste generated during cleanup of spills of various types like leakages from storage tanks, oil spills, vehicular leaks, and spills from maintenance activities, and hazardous wastes.

Studying sustainable airport waste management of Kansai International Airport, Japan, Baxter et al (2018) classified airport waste production into the airside area operations and landside functional areas. The airside waste producers are airport authority, airport maintenance firms, airport fuel farms and suppliers, air traffic control [ATC], fixed-based operators, flight catering centres and kitchens, General Aviation/Business Jet Centre, and government agencies. The landside waste producers are the airport authority, airlines, airport concessionaires, restaurants and s hops, airport hotels, car parks, cargo terminal operators and freight forwarders, ground handling agents and ground handling interchange, government agencies, car rental firms, Taxi-Cab Holding Bays, passengers, meeters, and greeters. Tofalli et al. (2018) using 27 flights from four airlines operating through Larnaca International Airport, asserted that waste were generated passenger during flight. The main waste were food waste, paper, and plastic items left behind. Blanca-Alcubilla et al (2019) argued that the characterisation of air cabin waste allows distinguishing between manipulated and unmanipulated materials. The study found that organic matter, paper/clipboards and packaging are the dominant waste generated on flights.

Baxter and Srisaeng (2021) asserted that at any airport, waste is produced by the various actors participating in the air transport value chains. These actors include the Airport Authority, airlines, airport concessionaires and shops, airport hotels and motels, car parks, cargo terminal operators, air freight forwarders, government agencies, ground handling organisations, passengers, meters and greeters, railway station (where applicable), restaurants, car rental firms, and taxi holding bays. Still focusing on airport waste generation, Sebastian and Louis (2021) agreed that airports generate significant waste, including municipal solid waste, construction and demolition debris, hazardous materials, and lavatory waste, providing insights into potential waste challenges at GMC.

Adopting the double diamond design process, Tjahjono et al (2023) stated that the sources of airport waste are the retail waste in airport terminals generated by tons of passengers at the airports. Referring to waste as refuge at Nnamdi Azikiwe International Airport, Abuja, Aisha et al. (2024) stressed that the wastes at this airport are solid waste and categorised as waste papers, accumulated rags, broken bottles and metals, nylons and polythene bags, food wastes and fruit peel, and medical waste.

In respect to cargo terminal, Pitt and Smith (2003) examined airport waste management and identified cargo terminal operators among airport waste-producing actors. Cargo-terminal waste included tyres, fluids, lightbulbs, plastic wrapping, papers, batteriesand wood/palletsthe Federal Aviation Administration (2013) identified cargo waste generated at the airport as food waste generated from offices, while the other significant sources of waste are plastic, and wood and wooden pallets. According to El-Din and Saleh (2016), air cargo terminals also generate both hazardous and non-hazardous wastes. The hazardous wastes are classified as hazardous if they exhibit one or more of ignitability, corrosivity, reactivity, or toxicity. International. Assessing waste management at a major European based air cargo terminal operator.

Baxter et al. (2018)

The study of Ozbay and Gokceviz (2022) characterised waste from different airport locations, including cargo officesand airline company offices, and compared their composition. Cargo-company offices had about 7.56% organic waste, while recyclable and combustible materials were both important components of waste. Baxter (2022) grouped the sources of cargo waste at airports as the airlines, cargo terminal operators, clients and government agencies., while various types includes tyres, fluids from equipment, universal wastes (lights bulbs, electronics, and batteries), woods and wooden pallets as well as plastic packing materials.

Adenigbo et al. (2025) examined cargo logistics at MMIA, Lagos and identified actors located within cargo-handling companies as actors located within the cargo terminal as cargo agents, custom officers, airport management, airlines, and cargo-handling companies. Their study confirmed the concentration and diversity of actors within the cargo-terminal environment.

# METHODOLOGY

## Research Design

The study adopted a systematic literature review (SLR) design, and guided by an actor-based analytical framework According to Pati and Lorusso (2018), systematic review approach was selected because it provides a structured and transparent method for synthesising existing knowledge and identifying research gaps within emerging fields of study.

## Sources of Data

The literature was conducted primarily through Google Scholar, supplemented by relevant institutional repositories and aviation and environmental organisations' publications. Google Scholar was selected because of its broad coverage of peer-reviewed articles, conference proceedings, institutional publications and other scholarly materials relevant to the multidisciplinary nature of airport waste management (Hoseth, 2011; Halevi, et al., 2017). The review focused primarily on publications published between 2000 and 2025 in order to capture contemporary developments in airport sustainability and waste management research. The starting year was selected to capture the development of contemporary sustainability and waste management (Al-Mafrachi, et al., 2020), while year 2025 represented the most recent complete publication year covered by the review. The initial search yielded 98 potentially relevant publications. Following the removal of irrelevant records and application of the predetermined eligibility criteria, 37 publications were retained for detailed analysis and synthesis. The selection process was based on the relevance of each publication to airport waste generation, the clarity of its methodological approach, the availability of sufficient information for analysis, and its contribution to understanding airport waste producers, waste characteristics, spatial distribution, or waste management.

## Method of Data Collection

Data were collected through structured searches using Boolean operators (AND, OR) to refine search results combinations. The keywords used were "airport waste" OR "airport solid waste" OR "aviation waste" OR "aircraft waste") AND ("passenger waste" OR "airline waste" OR "retail waste" OR "concessionaire waste" OR "administrative waste" OR "maintenance waste" OR "cargo waste" OR "logistics waste"). The study used a structured selection process based on four (4) of PRISMA stages of identification, screening, eligibility and inclusion to ensure transparency and reduce selection bias (Page et al., 2021). The study followed the PRISMA process of combining database search, remove genuine duplicates, screen systematically, apply eligibility criteria and arrive at the final study.

**Inclusion Criteria [IC]**

1. IC1 examined waste generated within an airport environment or activities directly associated with airport operations;

2.IC2 addressed one or more aspects of airport waste generation, including waste sources/producers, waste types or characteristics, spatial location, waste management, recycling, or sustainability;

3.IC3 were published between 2000 and 2025;

4. IC4 provided sufficient information to support extraction and thematic synthesis of findings; and

5. IC5 were available in English.

**Exclusion Criteria [EC]**

1. EC1 focused exclusively on general municipal, industrial, domestic, or healthcare waste without a direct connection to airport environments;

2. EC2 addressed aviation environmental issues without substantive consideration of waste;

3. EC3 were duplicates;

4. EC4  lacked sufficient information for meaningful analysis; or

5. EC5 were opinion pieces or other publications that did not provide sufficient evidence relevant to the objectives of the review.

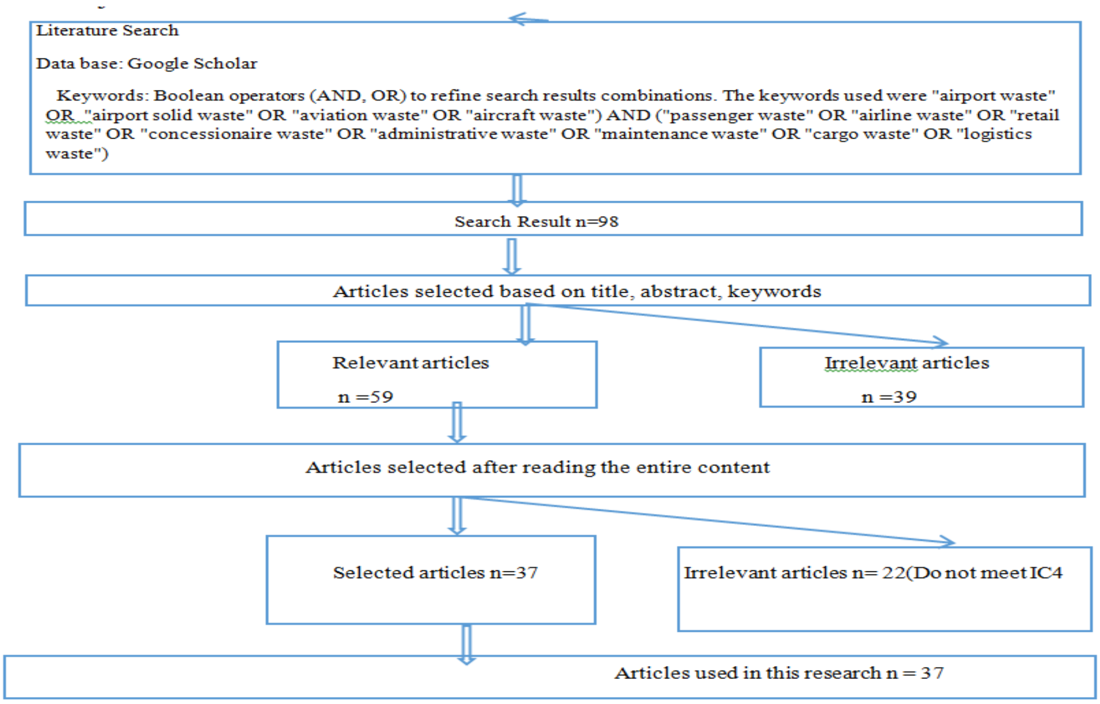


Figure 1: Reporting Items for Systematic Reviews (Adoption of PRISMA) Source: Researchers' Process (2026)

**Actor-Based Coding Framework**

The actor-based coding framework comprised six principal categories of airport waste-producing stakeholders/agents: passenger-related activities; airline and aircraft operations; airport authorities and administrative activities; airport concessionaires and commercial operators; airport maintenance and technical service activities; and cargo and logistics operations. These categories were used to systematically code the actors identified in the selected studies and examine their association with waste types, characteristics, spatial locations, and management implications.

### Data Extraction

A structured data-extraction framework was used to organise information obtained from the selected publications. Information extracted from each publication included **a**uthor(s), year of publication, geographical context, study setting, research approach, identified waste-producing actors, types and characteristics of waste generated, spatial location of waste generation, waste-management practices, and key sustainability implications.

### Method of Data Analysis

Thematic analysis was deployed to identify recurring patterns and grouping into themes related to waste-producing actors, types of waste, spatial distribution of waste within airport environments, waste management practices, and sustainability implications within airport systems. Thematic approach allows for synthesis of findings across different geographical contexts, including global, African, and Nigerian perspectives.

Thematic synthesis also enabled comparison of evidence across different geographical contexts, including global, African, and Nigerian settings (Yaro et al., 2026). The analysis therefore moved beyond a simple description of individual studies to identify similarities, differences, and gaps in the existing evidence concerning the actor–waste–space relationship within airport environments.

### Validity and Reliability

The quality and trustworthiness of the review were enhanced through the use of clearly defined search terms. Peer-reviewed and credible sources were included, while triangulation was achieved by comparing findings across multiple studies and geographical contexts, and types of airport activities.

### Ethical Consideration

The study was based mainly on secondary data, without any human participants. Ethical academic practice was strictly observed through proper citation of all sources and adherence to intellectual property standards.

## RESULT AND DISCUSSION OF FINDINGS

This chapter presents and discusses the findings from the review of literature on airport waste producers, waste characteristics, and the spatial distribution of waste generation within the airport environment. The discussion is organised thematically around the major categories of waste producers identified in the literature. It also compares the findings with previous studies in order to establish areas of convergence and divergence within existing scholarship on airport waste management.

### Classification and Spatial Distribution of Airport Waste Producers

### Passengers-Related Activities as Waste Producers

The review identified passengers as the largest and most visible source of waste within airport terminal environments. This finding is particularly relevant in the Nigerian context. Bello (2025) identified food waste, nylon/polythene materials, and paper waste as dominant waste streams generated within the Nnamdi Azikiwe International Airport, Abuja environment. She attributed this largely to passenger activities and terminal-based consumption patterns. The findings correspond with the study of Baxter et al. (2018), who observed that passenger terminals constitute major waste generation hotspots due to high levels of commercial consumption and passenger movement. The volume of passenger-generated waste is influenced by passenger traffic, waiting times, and consumption patterns. This agrees with Sebastian and Louis (2022), who reported that passenger behaviour significantly influences the volume and composition of airport waste streams, particularly in the landside operational areas. These activities includes the consumption of food and beverages, shopping, waiting, and the use of disposable materials generate substantial volumes of MSW. This category of waste make waste segregation and recycling difficult. This corroborates the study of Tjahjono et al. (2023), who estimated that passenger-related activities contribute a major share of terminal waste, particularly in departure lounges, arriving halls, and boarding gates, where consumption is concentrated. The predominance of passenger-generated waste indicates the increasing commercialisation and consumption-oriented nature of modern airport terminals

Table 4.1: Passenger-Related Activities as Waste Producers

| **Waste-producing actor/agent** | **Waste Stream** | **Waste StreamCharacteristics** | **Principal Spatial Location** | **Management Implications** |
|---|---|---|---|---|
| Passenger-Related Activities | Food and beverage consumption, shopping, waiting, movement through terminals, use of disposable materials | Food/organic waste, plastic bottles, nylon/polythene, paper, aluminium cans, mixed municipal solid waste; predominantly consumer-related and recyclable fractions | Passenger terminal areas. Departure lounge, Arrival hall, Boarding gates, Seating/waiting areas, Food courts and other passenger terminal areas | Source segregation, recycling, provision of appropriate collection points, passenger awareness and behavioural interventions |

Source: Authors' Compilation (2026)

**Airport Authorities and Administrative Activities as Waste Producers**

The review revealed that airport authorities and administrative offices generate institutional waste streams in smaller quantities compared to passengers and airlines. This includes office-based waste and maintenance-related materials from airport operations. This corresponds with the findings of Adebayo et al. (2022) on institutional waste management, which shows that administrative activities generate relatively predictable waste streams that are easier to manage through structured recycling systems. This suggests that airport authorities can significantly improve sustainability outcomes through office waste reduction strategies, paper reduction initiatives, and digital administrative systems.

Table 4.2: Airport Authorities and Administrative Activities as Waste Producers

| **Waste Producing Actor/Agent** | **Waste Stream** | **Waste Stream Characteristics** | **Principal Spatial Location** | **Management Implication** |
|---|---|---|---|---|
| Airport Authorities and Administrative Activities as Waste Producer | Administrative activities, office operations, facility management, landscaping and airport management functions | Paper/office waste, e-waste, toner and cartridges, break-room waste, green waste, special maintenance-related waste and, where applicable, construction and demolition waste | Administrative buildings, management offices, conference/training rooms, terminal support offices, maintenance operations and external airport grounds | Paper reduction and digitisation, office recycling, e-waste management, segregation and improved institutional waste-management systems |

Source: Authors' Compilation (2026)

**Airline and Aircraft Operations as Waste Producers**

Airlines generate waste primarily through aircraft in-flight catering services and aircraft turnaround operations. They are (i) deplaned aircraft waste. This is a specific type of Municipal Solid Waste [MSW] that is removed from passenger aircraft. This refers to waste removed from aircraft after flights. (ii) Lavatory Waste falls under the category of special waste and is generated when the lavatory tanks of the aeroplanes are emptied via hose and pumped into a lavatory service vehicle, which can be either a self-powered truck or a lavatory cart pulled by a tug. After the aircraft's lavatory tanks are emptied, they are refilled with a mixture of water and a disinfecting concentrate, commonly called "blue juice" The lavatory waste removed from the aircraft is transported to a triturator facility, generally located on the airside, near airline operations, for pre-treatment prior to discharge to the sanitary sewage system and publicly owned treatment works (POTW). (iii) Cabin waste. This is all waste generated within the aircraft cabin. (iv) Cleaning waste refers to all waste collected as a result of cleaning operations within the aircraft. This includes wastes collected by dedicated cleaning teams and also wastes collected by cabin crew during cabin reset (v) Catering (Galley) waste comprises all waste generated from in-flight food and drinks service. (6) Medical waste/sharps. Passengers with specified medical conditions are permitted to carry medical equipment on board commercial flights. Such items, when used, are classified as medical sharps waste and present a biohazard to cabin and cleaning crews if not disposed of carefully. Where medical sharps waste occurs on board, provision must be made to capture these in designated, puncture-proof containers. (7) Biosecurity-controlled International Waste. This is consistent with the International Civil Aviation Organisation (ICAO, 2023) submission that airline waste is tightly regulated due to international health and safety requirements, limiting opportunities for recycling, especially for international flights.

The regulated nature of airline waste further demonstrates the operational complexity associated with managing international aviation waste streams. This indicates that airport waste management systems must incorporate specialised handling procedures for aviation-related waste streams

Table 4.3: Airlines and Aircraft Operations Waste

| **Waste Producing Actor/Agent** | **Waste Stream** | **Waste Stream Characteristics** | **Principal Spatial Location** | **Management Implication** |
|---|---|---|---|---|
| **Airlines and aircraft operations** | **In-flight catering, cabin services, aircraft cleaning, aircraft turnaround, lavatory servicing and related aircraft operations** | **Cabin/deplaned waste, food and galley waste, paper, plastics, cans, cleaning waste, lavatory waste, medical/sharps waste and biosecurity-controlled international waste; includes regulated/specialised streams** | **Aircraft cabins, galleys, apron/ramp areas, ground-handling zones, aircraft servicing/catering points and airside operations** | **Specialised collection and handling, segregation, regulatory compliance, treatment of regulated waste and appropriate disposal/recovery systems** |

Source: Authors' Compilation (2026)

**Airport Concessionaires and Commercial Operators as Waste Producers**

Due to changing airport business models, commercial activities increased within the airport (Kanyio et al., 2023). This is consistent with Graham (2018), who emphasised that commercial activities in modern airports have expanded significantly and now constitute major components of airport environmental management challenges. These commercial activities, such as restaurants, cafes, duty-free shops, and retail outlets, are significant contributors to waste generation. These operators generate continuous waste due to high passenger turnover and consumption-driven services. This reinforces the findings of Bello (2025), who asserted that passenger-driven consumption and concessionaires' activities constitute the primary sources of municipal solid waste within Nigerian airport terminals. Retail and food service waste is particularly important because it is concentrated in high-traffic areas and often contains recyclable materials that are not properly separated. This also agrees with the report of Wilts and O'Brien (2022), who noted that retail and food-service operations are among the largest generators of recyclable waste within transport infrastructure.

The concessionaire waste are high in volume. They are mixed, highly recyclable and generated continuously airport operating hours. The density of these concessionaire waste within passenger terminals highlights the need for targeted recycling and waste segregation initiatives specifically designed for commercial operators. It also reinforces the importance of integrating sustainability requirements into airport concession agreements.

Table 4.4: Airport Concessionaires and Commercial Operators as Waste Producers

| **Waste Producing Actor/Agent** | **Waste Stream** | **Waste Stream Characteristics** | **Principal Spatial Location** | **Management Implication** |
|---|---|---|---|---|
| Airport concessionaires and commercial operators | Restaurants, cafés, retailing, duty-free operations, lounges and other commercial services | Food/organic waste, packaging, plastic bottles, glass bottles, aluminium cans, paper, receipts and other retail waste; generally high in recyclable and organic fractions | Food courts, departure terminals, VIP/executive lounges, duty-free shops, retail stores, commercial corridors, public concourses and back-of-house areas | Mandatory source segregation, recycling and resource recovery, waste requirements in concession agreements, and targeted collection systems |

Source: Authors' Compilation (2026)

**Airport Maintenance and Technical Service Activities as Waste Producers**

Airport maintenance and technical services are the behind-the-scenes, round-the-clock operations that are essential to airport functioning (Szrama and Gill, 2021). These operations are critical to keep the airfields, terminals, and aircraft safe, but often overlooked as a source of airport waste. Maintenance operations generate specialised and potentially hazardous waste. This is consistent with the findings of Baxter et al (2018) on airport environmental systems in Europe. The study asserted that maintenance facilities and technical workshops are major generators of hazardous and specialised waste requiring strict environmental management procedures. The required level of safety can only be achieved by proper maintenance of all the elements composing an airport. The basic components of maintenance are inspection, servicing, overhaul, and repair. Such waste streams require strict handling due to environmental and safety risks. This corroborates the report of the International Civil Aviation Organisation [ICAO] (2023), which stated that airport maintenance operations are important components of the aviation environmental management system.

The increasing generation of maintenance-related waste demonstrates the evolving environmental implications of technologically advanced airport infrastructure. This also points to the need for specialised waste handling systems at airports capable of managing electrical, hazardous, and mechanical waste streams.

Table 4.5: Airport Maintenance and Technical Service Activities as Waste Producers

| **Waste Producing Actor/Agent** | **Waste Stream** | **Waste Stream Characteristics** | **Principal Spatial Location** | **Management Implication** |
|---|---|---|---|---|
| Airport maintenance and technical service activities | Inspection, servicing, repair, overhaul, engineering, electrical and technical maintenance of airport infrastructure and facilities | Oils/lubricants, batteries, chemical solvents, hazardous materials, scrap metals, electrical cables, bulbs/lamps, electronic components, pipes, paint containers, wood, concrete and other maintenance-related materials | Hangars, maintenance workshops, ground-service-equipment zones, technical service yards, utility rooms, electrical substations, engineering units and restricted technical areas | Specialised handling of hazardous and technical waste, segregation, safe storage, recycling/recovery of metals and electrical materials, and appropriate treatment/disposal |

Source: Authors' Compilation (2026)

**Cargo and Logistics Operations as Waste Producers**

Cargo terminals and logistics facilities were also identified as significant waste-producing areas within the airport environment. Air cargo comes in all shapes, sizes, weights, and packaging. This heterogeneity influences the amount of waste produced in the handling of air cargo traffic (Rodbundith et al., 2019). In providing air cargo handling services, cargo terminal operators generate various types of waste (Waters, 2020). These wastes are mainly generated at the interface between landside and airside. The findings from the review of literature align with the study of Budd and Ison (2017), who observed that increasing air cargo activities contribute significantly to packaging waste within airports. The study further supports the argument that cargo-related waste streams possess high recycling potential, but are often poorly managed due to inadequate segregation systems. The high recycling potential of cargo-related packaging waste suggests that there are significant opportunities for resource recovery within airport logistics systems.

Table 4.6: Cargo and Logistics Operations as Waste Producers

| Waste Producing Actor/Agent | Waste Stream | Waste Stream Characteristics | Principal Spatial Location | Management Implication |
|---|---|---|---|---|
| Cargo and logistics operations | Cargo handling, freight movement, warehousing, storage, loading/unloading and logistics activities | Cardboard, shipping boxes, plastic wrapping, wooden pallets, crates, damaged-goods packaging and mixed commercial freight waste; substantial packaging-related fractions | Cargo terminals, freight-handling warehouses, logistics/storage areas, airside and landside cargo interfaces | Source segregation, packaging recovery and recycling, pallet reuse, material recovery and improved waste management at cargo-handling interfaces |

Source: Authors' Compilation (2026)

## FINDINGS, CONCLUSION AND RECOMMENDATIONS

**Summary of Findings**

The findings revealed that airport waste generation is a multi-actor process involving several stakeholders operating within interconnected airport systems. The major airport waste producers identified in the study include passengers, airlines, concessionaires, airport authorities, maintenance and technical services, and cargo/logistics operators. Each category of waste producer generates distinct waste streams with varying composition, volume, and management requirements.

The review identified that passengers and concessionaires emerged as prominent sources of waste within airport terminal environments. This is as a result of the intensive consumption activities within terminal facilities, making these locations priority areas for source segregation and recycling interventions. These waste streams are mainly concentrated within departure lounges, boarding gates, food courts, retail outlets, and terminal waiting areas due to high levels of passenger consumption and commercial activities.

The literature indicated that airlines and aircraft operations generate specialised waste streams. These wastes are predominantly generated within aircraft cabins, apron areas, and aircraft servicing zones located in airside operational environments.

Existing studies also demonstrated that maintenance and technical operations waste were also important, but often overlooked waste-producing activities within the airports. Waste associated with airport maintenance includes electrical waste, electronic waste, batteries, oils, lubricants, cables, damaged lighting systems, and other hazardous materials generated from the maintenance of visual aids, electrical systems, backup power facilities, communication systems, and baggage handling equipment. These wastes are spatially distributed across engineering workshops, technical service areas, utility compounds, and maintenance facilities.

In addition, evidences revealed that airport waste generation is spatially differentiated across the airport airside and landside operational areas. Airside operational areas were associated more frequently with technical, maintenance and specialised waste streams, whereas landside areas were predominantly associated with municipal, passenger and commercial waste streams.

In the Nigerian context, the reviewed evidence indicates persistent challenges relating to inadequate waste segregation, limited recycling infrastructure, and dependence on mixed-waste disposal practices.the study revealed that airport waste management practices remain largely underdeveloped and are characterised by inadequate segregation systems, limited recycling infrastructure, and dependence on mixed waste disposal approaches. Food waste emerged as an important waste stream in Nigerian airport-related evidence, reflecting broader consumption and waste-management challenges. However, the review also identified a significant evidence gap in Nigeria and other developing-country contexts, particularly concerning systematic identification and comparison of waste-producing actors, waste characteristics, and their spatial distribution within airport environments. The limited empirical evidence underscores the need for primary airport-level investigations to complement the existing literature.

## Conclusion

Airport waste generation is driven by multiple actors, each contributing distinct waste streams with unique compositions and spatial distributions within the airport. The study highlights the importance of adopting an actor-based perspective to improve waste management practices and promote sustainability. The review provides a conceptual and analytical foundation for future empirical investigations and policy-driven sustainability initiatives aimed at improving waste governance within airport systems, particularly in developing aviation environments such as Nigeria, advances the understanding of airport waste generation by demonstrating that sustainable waste management requires integrated, actor-based strategies that recognise the diversity of waste producers and the spatial complexity of airport operations. It provides useful evidence base for airport authorities, policymakers, and researchers seeking to improve environmental sustainability and resource efficiency within airport systems, particularly in developing countries.

## Recommendation

Based on the findings of the review, the following recommendations are proposed:

Airport authorities should implement actor-specific waste segregation systems at major points where waste segregation and collection system should be designed according to the types and location generated by each actor..

Source-segregation facilities should be strategically positioned in passenger terminals, food courts, lounges, retail areas, cargo terminals, and other identified waste-generation hotspots. Separate collection of organic, paper, plastic, metal, glass, and other recoverable materials should be encouraged to improve recycling and resource recovery.

Cargo and logistics operators should establish systems for the recovery and reuse of cardboard, wooden pallets, plastic wrapping, crates, and other packaging materials. Collaboration between cargo operators and recycling or resource-recovery companies could improve the circular use of these materials.Environmental policies should be implemented and monitored compelling airlines, concessionaires, and cargo operators to participate in integrated airport waste management programmes. There should be empirical studies on waste characterisation and quantification in Nigerian international airports to generate context-specific evidence on airport waste producers, waste characteristics, spatial distribution, and management practices. This will reduce the dearth of literature on this topic in Nigeria strengthen the evidence base for sustainable airport waste management, and support the development of policies and interventions.

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**Conflicts of Interest**

The authors declare that they have **no real or perceived conflicts of interest** that could have influenced the work reported in this paper.

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